THE

ELECTRICAL REVIEW.

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THE PACIFIC CABLE.

A BLUE-BOOK has just been issued containing the report of the Earl of Jersey on the proceedings of the Ottawa Conference, held in the summer of the present year. Accompanying the report is a full account of the proceedings, and also a mass of interesting correspondence relating to the Pacific cable question, some of which dates back as far as 1887.

The favourable character of this report constitutes a fresh step towards the achievement of the great scheme which we have so consistently advocated in these columns. But a danger arises from the fact that Lord Jersey, in common with the delegates to the Conference, appears to have been entirely dependent upon the opinions of interested contractors regarding technical points. More than one of these contractors has apparently forgotten that a good cause is often most deeply injured by its *too* enthusiastic advocates. As we have many times before stated, there can be little doubt that the Pacific cable presents no difficulty so far as the laying is concerned. The greatest depth to be encountered is apparently not likely to be more than 3,500 fathoms, as far as one can judge from the very meagre information existing for the long stretch between the Sandwich Islands and Vancouver. Lord Jersey states that the Eastern Extension Telegraph Company have already a cable laid at a greater depth than 3,300 fathoms between Java and Port Darwin, and that the Senegal-Pernambuco cable also is laid at a depth of more than 3,000 fathoms. The first statement is obviously incorrect, and a slip has now been attached to the Blue Book, stating that it was made on incorrect information and should be deemed omitted.

The second, if not absolutely incorrect, is misleading. We have before us the Admiralty list of 153 soundings taken by the ss. *Silvertown* in 1891, and 138 in 1892, previous to laying the cable in question. There is only one depth recorded of about 3,000 fathoms, and this appears to be unreliable. There are three more of rather over 2,800 fathoms, and four of about 2,700 fathoms, but the vast majority are under 2,000 fathoms. With Lord Jersey's statement, which immediately follows, we cordially agree.

"The difficulty will be to repair the cable. It is a serious operation in even 2,000 fathoms; but cables have been repaired in greater depths than 2,000 fathoms, and it cannot be said that they could not be repaired in more than 3,000 fathoms, although it would certainly be difficult, and might involve the abandonment of very large pieces of the cable, and the laying of corresponding new sections." There is a vast difference between maintaining a cable that for the greater part of its length is in very deep water and maintaining one that merely crosses occasional deep basins, which can easily be bridged over with a new length in the un-

fortunate event of an interruption occurring in that particular spot.

We have little doubt that a cable can be designed and manufactured to meet the necessary requirements, but before finally adopting any one of the various types that may be proposed, it would be very desirable to have a practical demonstration of its suitability for the purpose, by the repairing of an imaginary fault in an experimental length laid expressly for this object in the deepest water of the Bay of Biscay—about 2,800 fathoms.

No possible good can result from mis-statements of facts made with the transparent object of disguising difficulties which must arise sooner or later. On the other hand, when difficulties are frankly recognised, they can generally be successfully provided against.

Some of the opinions of delegates and others, which are specially quoted by Lord Jersey, are singularly incorrect and unfortunate. For instance, Mr. Lee Smith argued that because one or two tenders, or rather estimates, had been received from contractors, that they must know all about the Pacific; and he stated that for the West Coast of Africa cables no survey was taken, but an allowance made for risks. Now, if ever a route was carefully surveyed before laying a cable, it is just on this West Coast of Africa. The Silvertown Company, on one surveying expedition alone took some 411 soundings, and in addition to this routine work careful temperature observations were made, which resulted in the discovery that all along the West Coast of Africa there exists a cold current of water, so cold that a cable laid there in a depth of about 50 fathoms would be no more likely to be damaged by that pest of tropical waters, the teredo, than if it were laid in the English Channel. Sir John Pender in his letter to the Colonial Office, of November 17th, 1888, specially mentions that the Eastern Extension Company were unable to obtain any assistance from the Admiralty for the survey of that part of this coast covered by their cables, and the soundings were consequently taken at their own expense.

With Mr. Siemens's remarks, which Lord Jersey quotes at some length, we have already dealt.

So much for the technical side of the question. With the strategic advantages of the proposed cable Lord Jersey has nothing to do, and he merely makes the very obvious remark that two routes must be better than one. With the commercial aspect of the scheme he is equally reticent, being unable to furnish any reliable statement as to the probable cost, expenses, and receipts; but the general opinion of the Conference was that if the enterprise is undertaken with proper safeguards, it would entail little or no loss to the contributing or guaranteeing governments. Of its value to commercial enterprise there was but one opinion.

Speaking generally of the recommendations of the Conference, Lord Jersey concludes with the following remarkable sentence:—"It is within the power of Great Britain to settle the direction of their trade and the current of their sentiments for, it may be, generations. Such an opportunity may not soon recur, as the sands of time run down quickly. There is an impatience for action which would be sorely tried by delay, and most sadly disappointed by indifference to the proposals which are now brought forward."

MORE ELECTRIC TRACTION.

A PAPER on electric traction has been read before the Northern Society of Electrical Engineers by Mr. Alfred H. Gibbings.

It brings forward an old proposal, the utilisation of refuse destructors as a source of heat for producing steam pressure, and subsequently producing electrical energy.

The whole thing, like previous ones of a similar kind, is based upon the possibility of the storage of the electrical energy; but, like his predecessors, Mr. Gibbings fails to bring forward any storage system better than the well known batteries, and we well know that as they now stand they would never meet the requirements.

Battery traction remains just where it was before the reading of the paper. It is needless for us to again repeat at length the obstacles and difficulties in the way of battery traction with known apparatus.

The paper brings forward a system which, as it is at present impracticable, is hardly worth discussing; it is full of "ifs" of a very large order. Thus: "If the accumulator system can be arranged and worked so that the entire depreciation of the accumulators can be written off per annum out of lower costs of working than are possible with either of the other systems, then it is clear that traction by accumulators would be the most highly remunerative system of any form of traction yet devised." Why, certainly! Does the author imagine this grand conception has never struck anyone before? The author talks of the "advantages of accumulators," when all the time he really means the advantages of stored energy in a highly available form.

Unfortunately the storage battery depreciates too rapidly to allow of this *remunerative* system being realised; taken with the great cost of working battery traction, it is a hopeless case.

The paper, indeed, reminds us of a famous recipe for making hare soup, which began with, "First catch your hare." Mr. Gibbings's paper should have commenced "First catch your accumulator."

A trolley system worked from stationary batteries charged by power derived from refuse destruction is possible, and might be profitable; but at present, traction by batteries carried on the car, is neither successful nor profitable, although the power to charge them, *i.e.*, the steam, may cost nothing.

Besides the depreciation, the capital sunk in batteries has to be paid for. To charge batteries economically requires much longer time than the discharge, so that three or four batteries are required for each car, each battery consisting of from 30 to 50 or 100 cells, according to the E.M.F. fixed for working pressure; the cells would require to discharge up to 150 ampères or more if 30 only were used. With these figures before him, any electrical engineer can arrive at an approximate idea as to the number of cells required to run a tramway working, say, 20 cars on the line. And then the cells are heavy, and the cars carrying them weigh much more than trolley cars, say 2 tons more. To meet this, heavier rails are required; and further, the batteries have to be pulled about a good deal every four or six hours, as they must be replaced by freshly charged batteries at the end of short periods.

These are all well worn objections to battery traction as it stands at this date, but they are passed over in the paper as if they were entirely overcome. It is quite an easy and sometimes delightful method of solving problems, to start off by saying "let it be granted," *à la* the mathematician, and forthwith we can prove anything we may assert. But in practice we have to deal only with facts; nothing is granted, and nothing is to be gained by unfolding plans on the supposition that the elements of the scheme are practicable and ascertained to be existing facts, while yet they are only dreams of the future.

Battery traction is the ideal system, but of what avail can it be to propose elaborate arrangements for working batteries, such as we know have been tried and found wanting.

When the successful traction battery is invented there will be many schemes for working the system ready for adoption. Till then all proposals are premature and none of them advance the subject in the slightest degree unless they can begin by demonstrating a very considerable improvement in storage batteries, a great reduction in their weight and a higher rate of *charge*, and other obviously necessary improvements.

COMPARATIVE TELEGRAPH STATISTICS OF 1893.

FROM THE *Journal Telegraphique.*

Countries.	Germany.	Austria.	Belgium.	Bosnia-Herzegovina.	Bulgaria.	Denmark.	Egypt.	France.	Algiers.	Greece.	Hungary.	India.
Length of lines (kilometres)	123,285	29,767	6,303	2,845	4,819	4,683	3,109	91,400	7,176	7,671	20,804	69,156
Length of wires	444,399	88,295	31,037	6,428	9,516	13,201	13,375	303,302	16,482	9,213	57,706	216,457
Offices	19,384	4,229	970	112	151	410	226	10,909	379	190	2,228	3,627
INSTRUMENTS.												
Morse	15,870	3,396	1,486	175	325	399	223	12,042	501	263	3,215	6,906
Hughes	527	171	79	2	...	...	...	772	22	2	61	...
Miscellaneous...	11,501	22	226	...	...	159	265	5,196	47	8	65	11
Telegrams ...	33,172,116	12,068,084	5,414,864	496,520	1,173,566	1,817,718	1,721,874	47,017,117	1,574,586	429,970	6,522,302	4,585,606

Countries.	Persian Gulf.	Teheran-Bushire.	French Indo-China.	Dutch Indies.	Italy.	Luxemburg.	Natal.	Norway.	Holland.	Roumania.	Sweden.	Switzerland.	Tunis.
Length of lines (kilometres)	3,371	1,086	2,667	8,329	37,493	475	1,098	8,201	5,538	5,835	8,676	7,270	3,189
Length of wires	5,459	3,260	4,091	12,028	115,540	887	3,397	16,145	19,878	12,878	23,980	19,739	5,447
Offices	7	14	78	275	4,454	113	77	389	815	436	1,094	1,501	74
INSTRUMENTS.													
Morse	29	37	124	378	4,512	59	37	289	535	1,341	505	2,018	92
Hughes	...	...	7	...	127	...	...	...	74	9	...	49	3
Miscellaneous ...	...	...	9	57	94	47	141	109	382	103	24	211	18
Telegrams ...	125,470	124,627	258,202	586,177	9,681,912	111,317	637,680	1,740,180	4,429,771	1,649,294	2,101,850	3,838,323	442,827

PRESENT AND PROSPECTIVE DEVELOPMENT OF ELECTRIC TRAMWAYS.*

BY C. J. FIELD.

IT seems hardly necessary to review the past development of electric tramways; it has been made apparent on every side of us, commencing, it may be said, with the introduction of electric motors on a large scale on the roads of Richmond, Va., about seven years ago, by the old Sprague Company. This was the first commercial undertaking of any size or capacity for the operating of a large service of horse railroad with electric motors, and the conditions and requirements under which this contract was taken were enough to discourage any but the most persistent and courageous. Grades of 10 and 12 per cent., sharp curves, poor track to operate on, and no past experience to go by, were some of the difficulties encountered. This road developed the system in its main features as it stands to-day, two motors being mounted, independent of the car body, on the truck, and driving to the axle by gear. With the improvements and modifications which seven years have brought into the field, this system stands in the main what Mr. Sprague made it at that time.

The first motors installed on this road were 7½ horse-power each. Later on these were changed to 10 horse-power, and a year or two later 15 horse-power motors became the standard. Then 20, and now two 25-horse-power motors are the standard street railway equipment which is generally made.

Street railway managers were soon attracted by the results there shown, and the next large system to follow Richmond was Mr. Whitney's then new consolidated system in Boston, the West End Railroad. There the Thomson-Houston Company practically had the field for enterprise and experiment, and carried on still further the development which had been started at Richmond, working out still larger problems than had there been undertaken. The result is to-day that, outside of a few cable roads, there is not a street railway system of any size in the country where electric traction has not been, or is not being now introduced on an extended scale, requiring enormous additional outlay of capital in this installation. There had been before the commencement of electric traction a growing demand for more rapid transit in large cities, and this had to be met some way. The cable had been introduced in a number of cases, but on account of its excessive cost, and special requirements and conditions to make it a success, in addition to the necessity of a heavy traffic in order to make it a commercial success, its introduction had been limited to a few large cities.

The advantage of electric traction was that it was equally available to the little cross country horse line or the largest system in our large cities, and under the heaviest conditions of traffic and service. One of the first results of its introduction was the satisfying of the demand for more rapid transit, and the large increase in gross and net earnings, and the reduction of operating expenses, especially on the question of power. One of the early fields to be developed was the inter-urban service between cities, for connecting small towns with large cities. One of the first and most marked examples of this kind was the inter-urban service between Minneapolis and St. Paul. After its establishment it compelled six different steam roads to practically abandon the service they had been maintaining between these cities.

We have seen it in the last year or two carried still further at the World's Fair by its introduction on the Intramural Road, and now being further extended on the elevated structures, and there are now being equipped one or two of the large steam roads for handling special problems, as, for instance, the Baltimore and Ohio tunnel at Baltimore, where the entire freight and passenger service of the road is to be handled by large electric locomotives of 1,000 to 1,200 horse-power capacity. The amount of capital, and the confidence with which capitalists and investors have taken hold of the electric tramway, has been something marvellous, when we consider the short time they have been in service, and though you might find a few failures owing to poor management, over-capitalisation, or some other sufficient cause, in general we find an uninterrupted line of successful extensions and enterprises in this line. I will try to make a brief, general review, of the different parts of the electric tramway system, and show the development which has been made in each.

Road Bed.—There is probably no part of a street railway

* To be presented at the New York meeting (December, 1894) of the American Society of Mechanical Engineers, and forming part of Vol. xvi. of the *Transactions.*

system which was more antiquated in its general construction than the majority of the road beds were found in this country when cable and electric traction were first introduced, and it took some severe lessons in many cases to bring about appreciation of the necessity of good road bed construction. The old horse road construction was in somewhat the condition of the old steam road construction 50 years ago, being a stringer construction, with ties 4 to 5 feet on centres in the majority of cases, and a flat rail, either centre or side bearing, and weighing from 30 to 60 lbs. to the yard, spiked to the top of the stringers. The result naturally reached with the introduction of electric traction on such a track, with its heavy service and severe wear and tear owing to self-propulsion, was a failure of the road bed entirely. On paved streets the ties had to be placed sufficiently low to enable the use of paving blocks over them. Therefore, with the commencement of the introduction of girder and T-rails, which, when first introduced, were 3 to 4 inches, and in some cases 5 inches, in depth, it required the placing of these rails on a cast or wrought-iron chair or stringer in order to get the depth over ties for paving. This method proved very little better than the old flat rail, under the added requirements of the service, and especially at the joints, and contracting engineers and officials of street railway companies very rapidly reached the appreciation of the necessity of using the heaviest possible rails obtainable, and the rail mills were pressed to undertake the rolling of heavier and deeper girder and T-rail, and, after overcoming all difficulties, they have reached at present a state of development which gives us, we believe, a road bed construction equal to that of any steam road in the country; and the standard to-day for electric tramway road bed is 70 to 80-lb. T-rail, or 70 to 98-lb. girder rail, the depth of these rails running from 7 to 9 inches.

Ninety-pound rail, being 9 to 10 inches in depth, enables them to be spiked direct to the ties and give the necessary depth for paving. This heavy rail, with 8 to 12-bolt joint plates, supplies every requirement. The girder rail is being generally used in paved streets, and the T-rail on suburban roads and, for the last year or two, to a considerable extent on macadamised roads, and even in a few cases on paved streets. By the introduction of special details of construction, and especially on macadamised and asphalt streets, the T-rail seems to offer as good a road bed, both for the railroad and the public, as the side-bearing girder rail. Ties used should be standard railroad ties.

The special work on track work, such as cross-overs, turnouts, curves, &c., has also met with large improvement. The old form of special work was iron castings, which very rapidly depreciated under the conditions of this service. Next, we had introduced the rails cut into the special shape as required by conditions and bolted together. These, also, very rapidly depreciated, and became loose in the joints, &c. Now, we have as a standard for this special work, the steel rails bent to the form required, and surrounded by a mass of cast metal to hold them together, and one company is turning out this special work with the parts welded together; also in cast steel. One company is introducing track work in which, instead of joining up the rails with channel and joint plates bolted together, the rail is being welded electrically into a continuous rail. A section of track in Cambridge, Boston, and also one at Johnstown, were laid in this manner, and this year is being introduced on a very large scale on the entire system of a road in Brooklyn, N.Y., where 50 miles or more of 90-lb. rail is being laid in this manner. The experiment is a bold one, and deserves success. We have got to await a severe winter to see what success will be achieved by it. The process of welding this up is to weld two joints and skip the third, and come back at night, when everything is cool, and weld this third joint. By this process they expect to overcome the difficulties which they encountered last year, in which, after one winter's test, 6 per cent. of the joints pulled apart.

Track Bonding and Electrolysis.—We are hearing a great deal to-day about electrolysis and electrolytic action of the current on the return side of the tramway circuit. In the early introduction of electric tramways, and with the light section of rails, the usual method was to bond up the rails and connect them with the return copper or iron wire of varying sizes which was laid between the rails. At first the size was No. 4 and 6 wire, and later on 0 and 00 was used. With the introduction of 70 and 90 lbs. section of rail we have met the question of sufficient capacity in the conductivity of the rail. The present requirements are to bond the rail in such a manner as to ensure a continuous connection of all the tracks, and thus provide means for the return connection to the power station, and we believe it may be said that the best standard of construction to-day is to double bond all the joints of the rail with the shortest possible bond which is practicable, and cross bond each rail every few lengths, and also cross bond to the other track. This ensures a uniformity of potential in the rails. Then by connecting this track by overhead feeders run in the same manner as the feeders to the trolley, connected every half mile or so to the track, we believe we have a practical solution of the difficulties which have been encountered in the proper return of the current, and a prevention of the trouble which has been encountered where this return was not sufficiently provided for, and the current, taking to the water and gas mains, causing the trouble and damage resulting from same.

Line Construction.—When we run across some of the old cases of line construction, as at Richmond and other places, and then compare them with the present form of construction which is now being introduced, it gives us a better illustration than words can describe of the improvement which has been made in overcoming the objections which existed in the earlier work. Then we had for insulation old pieces of glass and porcelain and little blocks of wood, the whole making a poor mechanical and electrical job, and giving considerable trouble.

The standard of trolley wire then was No. 4. Now the standard is a No. 0 or 00 wire. Then the poles used were plain little telegraph poles, about 6 inches at the top and 8 inches at the butt, which quickly gave way under the strain of service. Now we have a well-built line, substantial in every respect. The poles used are either a heavy octagonal sawed pole, or various types of iron poles. Local city authorities, though, have compelled the use of iron poles in most cases, and various types of pipe and trussed sectional iron poles have been introduced. The difficulty with the iron pole construction is to get good insulation between the trolley wire and the ground. The general line material, such as trolley insulators, feeder insulators, pole insulation, &c., have all been brought to a high state of development, and at present we can purchase this material and know pretty well that we are getting first class insulating qualities. On all city work the general form of suspension for the line is cross suspension, with the poles located on the curb.

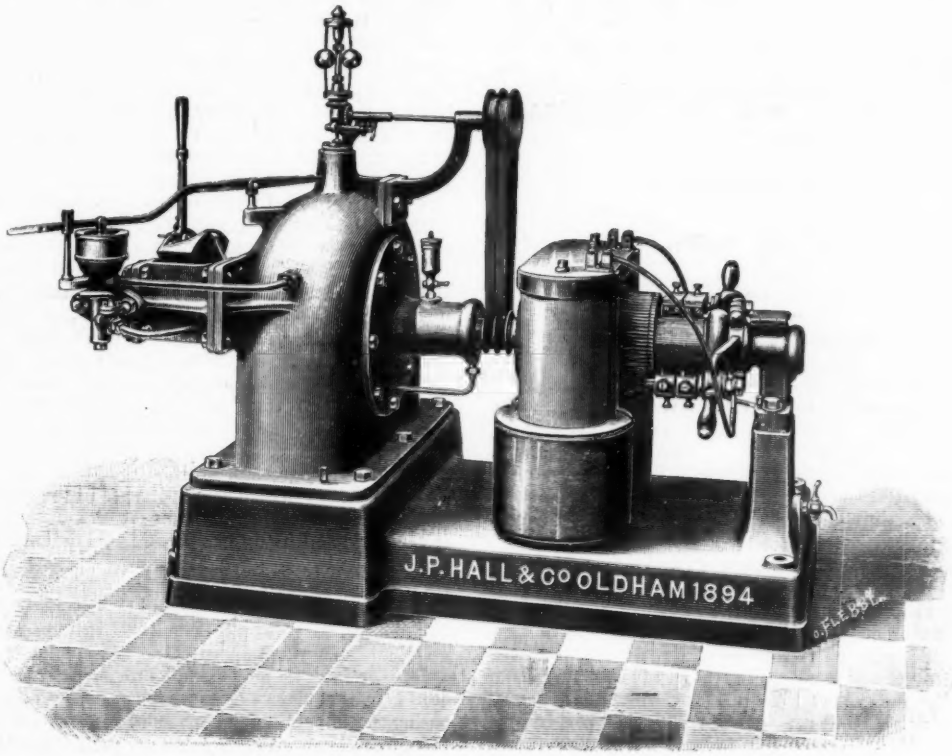
Feeder Wire.—Feeder wires have been more and more liberally introduced and used, and at present, on the best construction, the system is laid out and figured to maintain a distribution of potential over the entire system with a drop of not exceeding 5 to 8 per cent. under the most severe conditions or heavy stress of weather. Feeder wires in general have been run overhead, but we believe it is an assurance of better service on large roads to run the main feeder trunk lines in underground conduits, and we have done this in several cities with successful results. With proper arrangement of feeders, cut-outs, section insulators, &c., and proper distribution of the feeder lines on the switchboard, we have complete control of our system, and, in case of trouble, are able to localise that trouble to the smallest possible section of the line, and provide a quick remedy therefor.

Underground Conduits.—Underground conduits, or the placing of the trolley wire with all its feeders under the surface of the street, is the ultimate and desirable result to be obtained in our large city lines of electric traction, and cities are going to demand in the near future this method of service where the local conditions and requirements will warrant it. Underground conduits were attempted four or five years ago, but on account of insufficient experience, lack of engineering ability, or amount of money expended on the work, as well as a desire on the part of the company installing them to make them a failure, they were not in general successful. The first really successful underground conduit to be installed and operated was in Buda-Pesth, about seven or eight miles in length, and it is now being extended to 30 miles or more. The local conditions there were favourable, and the width of slot opening which was possible to be used there was not practicable in this country, owing to our waggon tyres. We have had, the past year, one or two conduits introduced on similar lines in this country on a

very small scale, at Chicago and Washington, and we will have within the next few months the introduction of a conduit, in one or two of our large cities, on a large commercial scale. The conduit to be most used will be one similar to a cable conduit, with the trolley conductors placed at the sides in the shape of a channel or angle bar or rod of iron or copper, which will be divided into sections, and fed by underground feeders laid along the line of the road. Various types of shoes or brushes will convey the current from the trolley wire to the motors on the car. Such a conduit, we believe, will only be successful where it is made a double trolley conduit, and not depending on the track for the return circuit.

The other type of conduit which may be used is one of the several which are operated on the closed conduit plan. None of these have been introduced on a commercial scale as yet. It is a very attractive method in many ways, also saving on the cost of construction of a cable conduit. There are numerous difficulties in regard to the electrical details which will have to be overcome before such a form of duct can be a success. The overhead line construction, though, will continue to be used in the majority of cases for many years to come, we believe, as the most practicable and best method for conveying the current to the motors. The cost of a well built trolley conduit in the form of a cable duct will, in most cases, exceed that of a cable duct on straight track, but less on curves and special work.

(*To be continued.*)



COMBINED DYNAMO AND TURBINE.

The dynamo illustrated above is constructed for an output of 50 ampères at 80 volts at 750 revolutions per minute, and is of the usual type manufactured by J. P. Hall & Co., of Oldham, the bed being prolonged to carry the turbine.

The armature is of the Gramme wire wound type, capable of carrying the full load with only a slight increase of temperature.

The commutator segments are of hard drawn copper, insulated entirely with mica.

The brushes are of carbon and the machine is so constructed that the lead of the brushes may remain the same for all loads without sparking. The magnets are of wrought iron let into the bed, and are shunt wound for charging accumulators or lighting direct. The electrical efficiency is about 86·33 per cent.

The turbine is of the Girard type, with wheel 10 inches internal diameter, carried on the end of the armature shaft, and is designed to give 6 B.H.P. when passing 36 cubic feet per minute at an effective head of 120 feet. The guide ports are four in number and are closed one after the other by a balanced regulating slide, the spindle of which passes through the bend admitting the water to the guide and which is regulated by a lever from an hydraulic cylinder, to either end of which water is admitted by a small balanced valve acted upon by the governor with which the speed can be adjusted while running. By means of a tap, the water to the hydraulic cylinder can be shut off and the slide worked by hand. The arrangement works almost silently.

RESONANCE.

Mr. C. P. Steinmetz, in the discussion on the paper of Dr. Pupin, read before the Philadelphia meeting of the American Institute of Electrical Engineers, and printed in the November number of the *Transactions*, claimed that resonance was merely a special case of a well known phenomenon. He recalled, says the New York *Electrical World*, the fact that if in an alternating circuit a self-induction is inserted, the self-induction will consume an E.M.F. lagging behind the impressed E.M.F. by 90 degrees, or a quarter period. The resistance will consume an E.M.F. in opposition to the impressed E.M.F.; and a condenser inserted in the circuit will take a current leading 90 degrees.

Next is considered what takes place if there is a circuit closed by a condenser, that is a circuit whose current leads the E.M.F. by 90 degrees or a quarter period, and having in series with the condenser a self-inductance. By self-induction a counter E.M.F. is induced which lags 90 degrees behind the current. But the current is 90 degrees ahead of the impressed E.M.F. Thus, the counter E.M.F. of self-induction is in phase with the impressed E.M.F. and adds itself thereto. Hence, the effective E.M.F. is increased by the self-induction being brought into phase with the impressed E.M.F., and if this increase is excessive, it is called "resonance," but it is nothing different from the action of

the choking coil, which produces a counter E.M.F., 90 degrees behind the current, and thereby, according to the phase relation between current and impressed E.M.F., either reduces the E.M.F. if the current is lagging, or increases the E.M.F. if the current is leading.

Thus, if we have a condenser with an impressed E.M.F. of say 100 volts, and taking 10 ampères with a self-induction in series which with 10 ampères current will produce a counter E.M.F. of 100 volts; this counter E.M.F. of 100 volts is now due to the lead of the current, in phase with the impressed 100 volts, adds itself thereto and thus gives 200 volts at the condenser terminals, with 100 volts impressed at the generator. These 200 volts will double the current and you get 20 ampères through. These 20 ampères will induce a counter E.M.F. of self-induction of 200 volts. Then you get 400 volts at the condenser terminals. That means 40 ampères and 400 volts at the self-induction. So it is seen that the self-induction in series will raise the condenser E.M.F. infinitely, that is, until the increase of the current causes the resistance to consume the total impressed E.M.F. It is therefore claimed by Mr. Steinmetz that resonance is nothing but our well known old friend self-induction, introducing an E.M.F. lagging 90 degrees behind the current, and thereby affecting the impressed E.M.F. according to the phase relation of the current.

CATHODE RAYS.

By E. E. BROOKS.

(*Concluded from page* 649.)

The first result might have been predicted from the older experiments. According to our views a variation in pressure of originating tube means variations in the velocity of cathode stream at formation, and we know, experimentally, that this alters the magnetic deflection. We have the pressure of observing tube constant, and the stream of particles entering it with different velocities, and thus get different deflections.

The second result is more important, and a valuable addition to our experimental knowledge. In this case we see that the velocity with which the cathode streams enter the observing chamber remains constant. We then learn that through a wide range of exhaustion the deflection produced remains constant. It is not quite true to say that this would be absolutely independent of pressure, on Lenard's own showing, for if the pressure in observing chamber became atmospheric, the stream would be practically lost before deflection could occur. Now this result could hardly have been predicted, and from it Lenard argues that if the deflection is independent of pressure, and nature of gas, it must be an effect independent of matter. But if we consider the actual nature of the magnetic action, we shall see that we are hardly in a position to say what result we ought to expect, and that there is no reason why we should not accept Lenard's results as an experimental solution.

The magnetic action upon the cathode stream has an important theoretical bearing. According to Maxwell, a stream of electrified particles should act like a current, and this view was experimentally confirmed by Rowlands, who rotated a charged conductor with great velocity. Now, if Crookes's theory is correct, we are dealing with a stream of electrified particles whose velocities are enormously greater than any we can produce by mechanical means, while still much less than "v," and therefore we should expect them to show electrostatic repulsion, and to be affected by a magnet. The experimental answer is conclusive. Both actions occur in a marked degree. We get distinct electrostatic repulsion between two streams in the same direction, while between the poles of a magnet the stream tends to place itself parallel to the molecular currents, and at right angles to the lines of force. It is important to note, however, that it behaves like a current moving away from the cathode.

It will be convenient to restate our position with regard to these deflections. We have reason to believe that a cathode stream produced at a lower exhaustion possesses less intrinsic velocity than one formed at higher exhaustions.

We also believe that the action of a magnet upon the stream will vary with the velocity of the stream, in accordance with Maxwell's theory. We have, however, also to bear in mind that a particle moving with less velocity takes a longer time to pass through the field, and this time question may be of considerable importance. Further, we have the effect of collisions, &c., to take into account. It would be hardly possible, therefore, to say at first sight what the net result of all these actions would amount to, without putting the matter to the test of experiment, and it is simply because we have experimental results to guide us that we say that Lenard's first result, when the cathode stream enters the test chamber with varying velocities, might have been predicted. In the second case, when the stream velocity is constant, we have no experiments to refer to. The result is that which theory would indicate, providing the net effect of the medium in test chamber could be neglected. The magnetic action itself should be constant, and if the medium effect and time effect tend to neutralise each other, Lenard's results would follow. But this is pure speculation, and the question may well be left an open one. We are under no obligation to provide a complete explanation, and the whole matter requires further experimental investigation. Crookes's theory is very incomplete, but bears every appearance of being correct so far as it goes, and we have no right in any research to resort to the ether until it has been most conclusively shown that a material explanation does not apply.

We have repeatedly referred to the velocity of the particles forming the cathode stream, and it might be asked what reason we have for assuming any very great value for it.

Now, by considering the phenomena of phosphorescence alone, it might be concluded that this velocity would not be much less than one mile or so per second, whatever the upper limit might be. For although we don't know in how far phosphorescence is due to the negative charge carried by the particles, experiment leads us to conclude that it is greatly dependent upon their velocity. Substances which phosphoresce readily, like calcium sulphide, calcite, wollastonite, zirconium oxide, &c., begin to do so at a comparatively early stage in the exhaustion, while still outside the dark space, showing that even then some particles in the cathode stream manage to reach them. And about this intermediate stage it is easy to see the cathode stream, and determine its general direction. As the vacuum improves, the glow of these substances steadily increases in brilliancy, while other substances, which, like spinelle, for instance, phosphoresce with difficulty, begin to glow only when the vacuum becomes really good, and sometimes approaching non-conductivity.

If, therefore, we may assume provisionally that mere bombardment is sufficient to cause phosphorescence, and remembering that all substances in vacuo, or at normal pressure, are being ceaselessly struck by gaseous particles in the course of their ordinary diffusive motion, then we may conclude that these diffusive velocities are too low to excite phosphorescence. Now, by the kinetic theory of gases, the pressure in dynes per square centimetre on the sides of a vessel containing a gas is numerically equal to $\frac{2}{3}$ of the kinetic energy of motion per cubic centimetre, or $p = \frac{2}{3} \cdot \frac{m v^2}{2}$, and, therefore, $v = \sqrt{\frac{3p}{m}}$, where m is the mass of a cubic centimetre of gas. Filling in values for air, we find v = about 500 yards per second, for hydrogen v = about $1\frac{1}{4}$ miles per second. In a vacuum these values still hold good, and if they are insufficient to occasion phosphorescence, then either the particles in the cathode stream must move with greater velocities, or else phosphorescence is mainly due to the effect of the static charge. While the true nature of the phosphorescent effect remains unknown, these ideas can only be used as guides to further experiment; but bearing in mind the existence of diffusive gaseous bombardment, it is curious to note the analogy between the colour of the fluorescent tinge in certain bodies in daylight, and the colour of their phosphorescence in vacuo. For instance, lead glass has a distinct blue tint, and phosphoresces bright blue, while soda glass has an equally characteristic yellowish-green tinge, and a similar, but more intense phosphorescence. We may also note the colour of rubies and their ruddy glow, and that of alumina, in vacuo, and it may not be altogether accidental that while strontium hydrate and sulphate phosphoresce more

or less of a blue colour in vacuo, strontium sulphate occurs native in the form of blue crystals of celestine. In some cases, however, the colour of a crystal and the colour of its phosphorescence are very different.

If, instead of crystals of more or less uncertain composition, we examine amorphous substances chemically prepared, it is well known that the colour and intensity of the phosphorescence is often very greatly influenced by the presence of slight impurities, or by admixture with other substances in larger amount. Mr. Crookes has studied these effects in his researches on the phosphorescent spectra of the rare earths. It is, in fact, an open question as to how far phosphorescence can be regarded as a physical property of a perfectly pure substance. I have come across salts which give bright characteristic phosphorescence when prepared with ordinary care, and which refuse to phosphoresce at all, or only do so slightly, when carefully purified.

Other curious phenomena have been recently described by Goldstein. He finds that most of the haloid salts of alkaline metals are more or less altered in colour by bombardment in vacuo, and that the new colour may last a considerable time. This is similar to an observation of Crookes in the case of alumina, and the writer has also noticed a similar effect.

Returning to the question of cathode stream velocities, it is evident that if we can approximately determine its value, we shall have valuable evidence to aid us in discriminating between the material and etherial ideas, for etherial velocities are so enormously greater than those of gross matter, that if it could be shown that the cathode stream moves at a rate in any way comparable with the velocity of light, it would be almost conclusive evidence in favour of Lenard's views, while conversely an opposite result would tend to confirm the existing theory. As we have reason to believe that the rate in question varies with the exhaustion, and with the length of path available, it is evident that nothing like a constant value can be looked for. All we can expect to do is to determine the order of velocity we have to deal with. It is, perhaps, unfortunate that the only methods of getting at the result by calculation really assume the existing theory, so we must not lay too much stress upon our results.

I believe Goldstein made the first attempt at a solution. His method is unknown to me, but his result came to the probably excessive value of about 500 miles per second.

In 1888, not knowing that the problem had been previously attacked, I endeavoured to obtain an approximate solution in one particular case. Starting with Crookes's experiment of melting a bit of platinum in the focus of a concave terminal, it is evident that the energy required can be written down in terms of the weight of the platinum, its specific heat, and final temperature. The mass of residual gas can be determined from the volume of the tube and its degree of exhaustion. Only the wildest sort of a guess at the number of impacts in a given time can be made by considering the ratio between surface of concave terminal, the surface of tube, and allowing for misses, &c., but on the assumption that every molecule in the tube had to hit the platinum 1,000 times, the velocity came out about 12 miles per second. Just to indicate the quantities we are dealing with, I may say that on this assumption the number of individual impacts required to raise $\frac{1}{10}$th gramme of platinum to a temperature of 2,000° C., supposing no loss of heat, is about 10 trillions or 10^{19}.

In 1892, Lord Kelvin, using the same idea of energy, but treating it in a very different way, showed that certain of Crookes's results could be accounted for by assuming a velocity of about 1 kilometre, or 1,100 yards, per second. (Electrical Review, December 16th, 1892.)

Since then Prof. J. J. Thomson has also given a solution, but I have not his method or result at hand. However, so far as I remember, it was a rather high value, approaching 100 miles per second.

These results differ widely, as might be expected, and so no doubt do the values in actual practice, for reasons already stated, but they are all so far less than "v," that we are justified in believing that we are dealing with the velocities of material particles.

As regards the discharge itself, we may take it as proved that the cathode stream, once started, is independent of the current. The way in which they are related, the connection between them and the low vacua stratifications, and the nature of the difference between a positive and a negative terminal are questions to which as yet we can return little or no answer. In a paper on the stratified discharge (Electrical Review, April 1st, 1892), I have given experimental reasons for believing that the positions of the striæ depend upon their own self-repulsion and the pressure of the cathode stream. All observers seem to agree in regarding the striæ as distinct units, which receive and hand on impulses from one to the other, perhaps involving the successive formation and breaking down of polarised chains, and most of them regard them as the actual mechanism by which the current passes. As stated in the paper above referred to, I am inclined to regard both the cathode stream and striæ as being independent of the passage of the current itself, but as physical processes intimately connected with it. The views put forth by Profs. Schuster and Thomson as to the electrolytic nature of the current transfer, and the dependence of the current upon dissociated ions, seem to be on the whole the most satisfactory hitherto advanced, but are too extensive and intricate to be adequately discussed in this article.

We may here note an important difference between a disruptive discharge and a current. In spark discharges, continuous in direction, the heat production is partially localised. If induction coil sparks are taken in air between iron wires, the negative wire becomes intensely hot and fuses, while the other remains comparatively cool. This effect has no connection with ordinary $C^2 R$ heat. In vacuo the same phenomena continues, and becomes most perceptible about the point of maximum conductivity. The fall of potential in the neighbourhood of the cathode is disproportionately great, and the resistance to the discharge seems to be made up of a possibly ohmic resistance proportional to the length, and a resistance at the surface of cathode and gas. If the cathode is too small, it becomes red hot or fuses, or the discharge breaks out through the glass coating of the supporting wire in vivid incandescent jets, decomposing the glass in its passage. Particles of metal (least in the case of aluminium) are torn off the cathodes, and driven away like the gas particles in the cathode stream, but apparently differ from the latter in soon being deflected from their course by the walls of the tube. If metallic salts are placed on the cathode, in certain cases and at certain pressures, a characteristic glow or brilliant incandescent spots are formed, which I have shown to give the spectrum of the metal. (*Chemical News*, July 17th, 1891.)

There is no absolute pressure at which a tube becomes non-conducting. It depends upon the size and shape of the terminals, and the part of the tube in which they are placed, to a far greater extent than it does upon their distance apart. For instance, I made a tube with three terminals, of different sizes and shapes, two rather large ones within an inch of each other, and one small one several inches away. At the critical point, the discharge refused to pass between the two nearer terminals, while it still passed readily between the two furthest apart. This, in accordance with results obtained by Hittorf and others. Mr. Crookes has also shown that the conductivity depends in a most curious way upon the contents of the tube, and that one and the same tube may possess different conductivities in different parts.

The question which occurs to one most frequently is, does the cathode stream stop because the current cannot pass, or does the current stop because the cathode stream cannot leave the terminal? We know that once started, the two are independent, and yet there must be a close relation between them at first. It is clearly quite insufficient to attribute the cathode stream to a repulsion of like charges, (1) because we then ought to get the stream after current itself has ceased, for we can still keep the electrode raised to a high negative potential, (2) because the same effect should occur at the anode. A satisfactory hypothesis has yet to be framed. Probably we shall first require to know something about the surface phenomena at the anode. One interesting feature at the latter may now be mentioned, I believe, for the first time, although no doubt it has been frequently observed. When the exhaustion has progressed to such a degree that the last lingering traces of stratification have faded away around the anode, there usually remains one luminosity directly attached to the anode itself, which persists for some time after the independent striæ have disappeared, and then gradually becomes fainter and dies away as the exhaustion increases. This luminosity possesses two distinctive features—first, it

is always directly attached to some part of the anode, and no dark space or separation can be detected between them; second, it appears to be repelled by the cathode, and if the two electrodes are not too far apart, always takes up its position on the side of the anode remote from the cathode.

In such work it is often convenient to have a ready means of following changes of resistance in vacuum tubes, and to be able to determine their values with approximate accuracy. Ordinary methods do not apply. De La Rue used a rather complicated arrangement of resistances and vacuum tubes on the lines of a Wheatstone bridge, but after some trouble I found that the very fact that the nature of a vacuum tube resistance is totally different to ordinary resistances, enabled me to obtain fairly satisfactory results in the following simple way:—An adjustable liquid resistance was made on Hittorf's principle, using a solution of cadmium iodide in amylic alcohol. The tube was graduated in millimetres, and the resistance per millimetre determined by measuring the resistance of various lengths in the usual way. When used it is to be connected as a shunt to the tube in question, and then the upper electrode lowered until discharges just cease to pass through the tube. By alternately slightly increasing and diminishing the length of liquid, it is now easy to determine the point at which discharge passes through either path with equal readiness, and the resistance of the liquid column may be taken as equal to the resistance of the tube.

I have not attempted anything like a complete statement of the subject. There are many interesting facts connected with the discharge well known to experimenters, which have as yet received no adequate explanation. For instance, under certain conditions, it is easy to produce the most brilliant phosphorescence in a tube in which the pressure is perhaps a thousand times too great to produce the phenomena in the usual way. I think, however, we may take it that the kinetic theory of gases is not yet quite out of date, and also that it will be as well not to make too sure that we have found a direct method of experimenting upon that elusive medium, the luminiferous ether.

[Since writing the above, I have met with a paper read by Mr. Burke at a recent meeting of the Physical Society. Beccaria, about a hundred years ago, noticed that a faint glow was produced when exhausted bulbs were opened in the dark, and Prof. J. J. Thomson has suggested that this effect, evidently due to the impact of the inrushing air, may be analogous to the effect of the cathode stream. Mr. Burke, however, concludes from a large number of experiments that this glow is only produced when solid particles of some kind are projected against the walls of the bulb, and that when such solid particles are absent, the glow is absent also. After seeing the account of Mr. Burke's paper, I carefully opened in the dark some nine or ten vacuum tubes, which had been lying unused for many months. Two or three of these were empty, the others contained various crystals and salts. The results agreed with those obtained by Mr. Burke. The empty tubes gave no glow, all the others gave in varying degrees a visible flash, most intense in the case of a tube containing impure calcium sulphate. These results are interesting as being undoubted cases of phosphorescence due to impact, but are most likely not directly related to cathode stream phenomena. The impact of the solids will produce frictional excitation quite sufficient to account for the observed effect, while the impact of gas and solid will not; and if the velocity of the air jet is less than that of the cathode stream, as is probably the case, its action alone will be practically nil.]

DIOPTRIC GLASS SHADES.

By A. P. TROTTER.

There are certain inventions, such as automatic tramcar starters, railway-carriage station indicators, and telegraphs for transmitting writings and drawings, which seem bound to be invented and re-invented at regular intervals. The reason is that they are not particularly hard to invent, and each inventor, because he does not see them in common use, thinks that he is doing original work. The construction of reflecting or refracting appliances for the diffusion, and more particularly for the uniform distribution of light, is, I believe, another example of this class. These problems have been solved and repeatedly solved, because up to the present there has been no real demand for them, because they are expensive luxuries, and because there is generally some unforeseen difficulty in the way.

The first attempt to distribute light uniformly is to be found in the patent of Smethurst and Paul, No. 2,654, 1802. They describe a reflector "that shall be so formed as to reflect those rays issuing from the flame of the lamp, which without their interposition, would fall in a direction in which they would be useless . . . in such a manner as to diffuse and distribute them over the whole surface or extent of space to be illumined, so that the whole of the light falling on every portion of such surface or extent of space, both from the direct rays of the lamp and after reflection from the reflector, may be as nearly equal and uniform as is practicable." This was a good beginning, but they merely attempted to superimpose a uniform distribution upon an area already unequally illuminated, and moreover, their reflector would not have fulfilled the problem, for they directed the rays at angles whose tangents are as 1, 2, 3, &c., instead of as $\sqrt{1}$, $\sqrt{2}$, $\sqrt{3}$, &c. I went into this question of reflectors in 1888, and wrote an article in *Industries** on the subject. A reflector with an entirely wrong curve was patented a few years ago, but even this has not met with success.

The method of diffusing and distributing light by means of prismatic corrugations on clear glass, has been attacked by several inventors. The last example, that of MM. Psaroudaki and Blondel, has been recently described in detail in the French electrical journals.† Two years ago M. Fredureau described a somewhat similar invention before the Académie des Sciences,‡ but it is not quite clear whether he aimed at distribution or at concentration only. The specimen of his globe which I have seen, appears to be suitable for directing most of the light downwards in the neighbourhood of the lamp. Some years ago, M. Weissenbruch proposed, and possibly made, some shades, for the uniform distribution of light; but I have never seen any account of his invention. The shades of MM. Psaroudaki and Blondel are now being placed on the market by MM. Engelfred et Cie., of Paris. Whatever work M. Blondel puts his hand to is sure to be well done, and I have no doubt from examination of the details of his system, that the globes will do all that is claimed for them. My own work in this direction has been heard of now and then, but the reasons why the shades themselves are practically unknown and forgotten may be worth relating in connection with this recent invention which so closely resembles them. As no account whatever has been published of my dioptric shades, I venture to give their history as briefly as possible, for the purpose of comparing my experience with the prospects of this latest invention.

In 1879 I saw a short article, or letter, in some technical journal for which I have more than once searched, but which I have never seen again. The excess of light in the neighbourhood of a lamp-post—an arc lamp I think—was pointed out, and some suggestion was made for distributing the illumination, probably by reflectors. Soon after this I sketched an arrangement of prisms, but did not spend much time upon the matter until 1880. I only hope that MM. Psaroudaki and Blondel used some such device as that which I employed for the laborious calculations. In Deschanel's Physics, a graphical construction is given for finding the path of a ray through a prism. It is easy to convert this diagram into an instrument, and such an instrument § was made for me by the Cambridge Scientific Instrument Company in 1880. The curved faces of my prisms were calculated approximately as polygons. One set of these, for a single pane of glass, ran into nearly 3,000 separately calculated angles. After visiting the Paris Electrical Exhibition in 1881, and finding nothing of the sort there, I applied for a patent No. 3,515. In July, 1882, I went round to four

* *Industries*, Vol. v., p. 532.

† *L'Eclairage Electrique*, No. 7, October 27th, 1894, p. 308; *L'Industrie Electrique*, No. 67, October 10th, p. 438; *L'Etincelle Electrique*, No. 1, p. 1, November 3rd, 1894.

‡ *Comptes Rendus*, Vol. cxv., p. 1,064, December 12th, 1892.

§ *Engineering*, Vol. xlvii., p. 559, May 17th, 1889.

large manufacturers of flint glass ware, but after examining my drawings, templates, and plaster models, they all declared that it would be impossible to mould such things. One of them, on being asked the value of the refractive index of his flint glass (an absurd question to put to a glass maker), replied, "Value? why it has not got one!" But in August, 1882, Messrs. Greener & Co., of Sunderland, undertook to try the job, and the patent being too far gone to be proceeded with, was again applied for in January, 1883, No. 233. At about the same time the French, Belgian, Austrian, American, and German patents were applied for. The German office objected that the idea was very old, and referred me to descriptions of lighthouse lanterns. The others* were granted, and were handed over to an agent, who, if I remember right, allowed them all to lapse without doing anything with them. The first lantern was tried at the Millwall works of Messrs. Latimer Clark, Muirhead & Company. No photometric measurements were made, but it was evident that a certain distance from the lamp there was more light with the lantern than without it, but the weight of the glass was terrible. The manufacture was soon afterwards taken up by Messrs. Moore & Sons, of South Shields, who executed the difficult task of cutting the iron mould to the templates with great accuracy. The scientific part of the invention was described in a "selected paper" of the Institution of Civil Engineers, Vol. lxxviii., p. 346. An excellent abstract of this, in French, with illustrations, appeared in *La Lumière Electrique*, Vol. xiv., p. 98, October 18th, 1884. No account has ever been published in an English journal; the details are of purely optical interest.

Seeing that I had in view two definite problems, namely (1) the diffusion of light, without the loss caused by ground glass or opal shades, and (2) the distribution of light as uniformly as possible over a definite area, and that I set about it by simple geometrical optics, it is not surprising that the French inventors, attacking the same problems by the same means, should have arrived at results which are in many details identical with mine. I studied the question of diffusion (totally different from distribution) because it seemed likely in 1881 that glow lamps when improved would be so bright as to be unbearable to the eye unless shaded. As a matter of fact, lamps were run then a good deal brighter than was the fashion in 1893. My diffusion shades were cylindrical with a hemispherical bottom. Flutings were formed by moulding, both on the outside and on the inside. To enable the moulds to strip, the outer flutings ran round in rings, and the inner ones ran up and down. The French shades are globular, each half being exactly like the bottom of my shade.

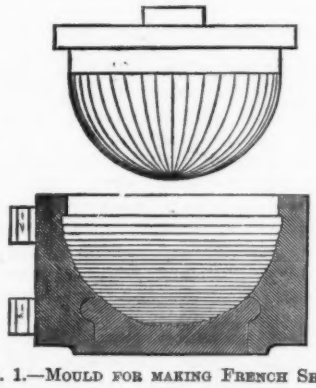


Fig. 1.—Mould for making French Shade.

A circular fluting is not the best form, and the French inventors seem to be of the same opinion, as is shown in the accompanying illustrations.

My shades multiply the source of light into about 300 little images, each well formed and distinct, and, of course, $\frac{1}{300}$th of the power of the original. They were used to light the subway from the South Kensington Station to the Health Exhibition in 1884. I only know of three in actual use to-day, these are on the staircase of the *Standard* office, and I look affectionately at them when I go down Shoe Lane.

* American, No. 330,356, 1885; French, No. 153,303, 1883; Belgian, No. 60,328, 1883; Austrian, No. 7,228, 1884.

I knew a man who found them useful for mixing paint in. I have none in my own house, I am difficult to please in the matter of fittings. Mr. Moore asked me in 1885 whether

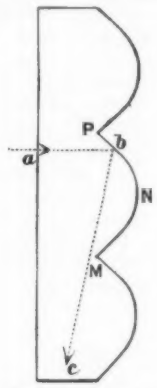


Fig. 2.—(From *L'Industrie Electrique.*)

my invention could not be adapted to gas burners. I unhesitatingly said "No! because a gas flame is so widely different from a mathematical focus, and all my calculations would be thrown away." He soon afterwards applied the

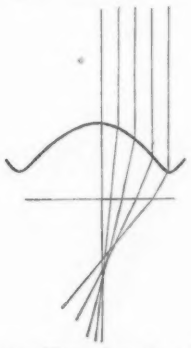


Fig. 3.—(From *Proc. Inst. C.E.*)

patterns used on his imitation cut glass jelly dishes to gas shades, and I am glad to see them in use in hundreds of thousands. I hope he has recouped himself for the large cost of my moulds, to which he would not allow me to contribute, since it was not his custom.

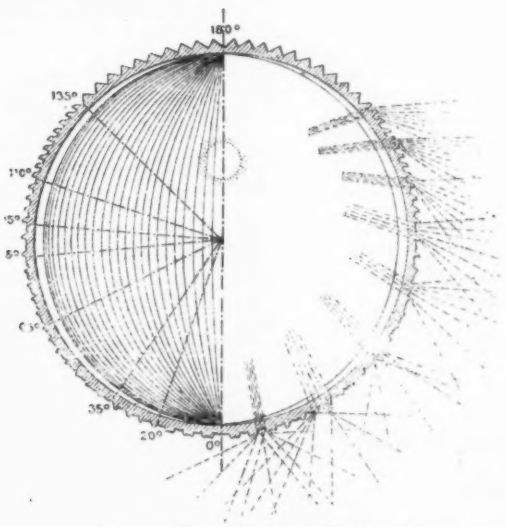


Fig. 4.—(From *L'Industrie Electrique.*)

The French invention is, as might be expected, more tasteful, and, indeed, I tried to introduce the same form in 1887, but was advised by the largest dealers in electrical supplies, who had handled my shades in small quantities, that a globular shade would not "take," and they did not care to give an order to help to start it. I went as far as making templates and plaster models, but under the circum-

stances, Mr. Moore did not care about touching it. I think it would have been a useful and far less ugly shade than my first. Mr. Stepney Rawson estimated the absorption of light to be about 3½ per cent; this is impossible, but neither he nor I could account for so small a loss. I believe it to be about 8 or 9 per cent. when quite clean. But here comes one of the great difficulties. Such shades are very liable to catch the dirt. Mere wiping is of no use, they must be washed and scrubbed. This has been simply fatal to the more important class of shades, to which I must now pass.

The methods adopted by the French inventors for the uniform distribution of light are a good deal more complicated than those which I employed. They make use of internal reflection to a considerable extent, and the profile of some of their prisms is very intricate. This must entail very expensive moulds, (one of mine cost £40, if I remember right), great care in annealing, lest the sharp angles become rounded or the whole shade warped, and the difficulty of cleaning seems to be very serious. The general outline of the French shade has an immense advantage over mine from an æsthetic point of view. Theirs is a beautiful sparkling globe, and mine was a particularly ugly lantern.

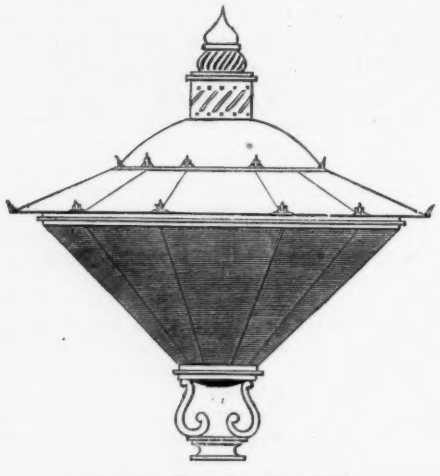


Fig. 5.—(From *Proc. Inst. C.E.*)

I was so careful of the theoretical design, that I never gave the beauty of the shape a single thought. My lantern was designed on the assumption that no useful light is emitted upwards from an arc. The horizontal ray strikes

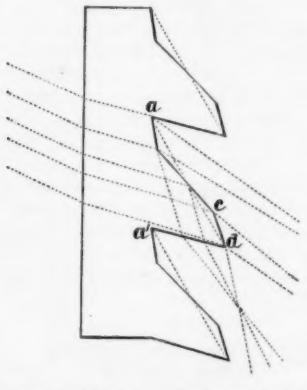


Fig. 6.—Profiles of Prisms. (From *L'Industrie Electrique.*)

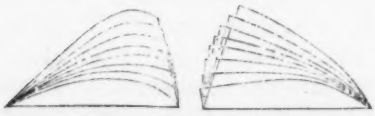


Fig. 7.—Profiles of Distributing Prisms. (From *Proc. Inst. C.E.*)

the glass at 45°, and becomes refracted in the thickness of the glass through 17°, and is therefore well on its way downward before it reaches the prisms. The special shape of the French globe does not take advantage of this angle of incidence. Considerable quantities of my glass for lanterns was sold in 1884 and 1885, but I do not know of the existence of a single lantern now. I have not even got a sample pane. One company who took the largest quantity, from motives of economy or æsthetics, upset all my mathematics by using only eight panes instead of ten in each lantern, thus making the sides much steeper. I was always too disgusted to calculate what really happened under these conditions, but I was not surprised when

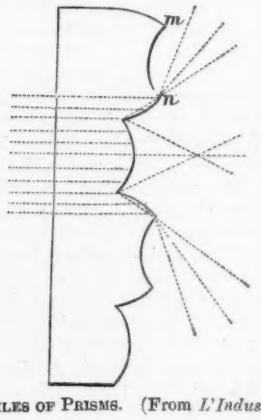


Fig. 8.—Profiles of Prisms. (From *L'Industrie Electrique.*)

their orders stopped. One of the large galleries of the Health Exhibition was entirely lighted with my lanterns, and the jury, after carefully examining the uniformity of the illumination, awarded me a silver medal. After ten years' internal reflection and experience with photometry, I am inclined to think that the distribution of illumination in this particular case would have been just as good without my patent glass, and I cannot make up my mind what I ought to do with the medal.

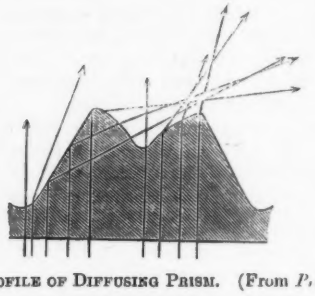


Fig. 9.—Profile of Diffusing Prism. (From *Proc. Inst. C.E.*)

For widely-spaced lamps on fairly high pillars, it is certainly possible by means of either of these inventions to distribute the light fairly uniformly over a definite area. But the real question is: Does anybody really want this? I once thought that it was of manifest importance, but to-day I am convinced that for ordinary street lighting a distribution such as that which is to be found in most of the streets in St. Pancras is quite uniform enough for all practical purposes. True, the parts midway between the lamps are dimly lighted, but if the superfluous light were taken away from the brilliant parts, and were spread over the dark parts, I believe that the general effect would not be so useful as at present. This was the object of my invention; and, if I understand the matter rightly, this is what MM. Psaroudaki and Blondel are attempting to do, and no doubt succeed in doing. But the superfluous light is shed over a very small area, and the dimly-lighted space is large, and the superfluous light would go a very little way towards illuminating it well, and is more useful where it is. I have only come to this conclusion by careful observation and actual measurements of street illumination during the last two or three years.

A smaller distributing shade moulded in one piece, was tried in "the Wimbledon experiment" of 1884. The photometric tests, according to Mr. Preece's report* were very satisfactory, but the general effect to the eye, which is, after all, the main test, was no better than that of a well-designed

* Electrical Review, Vol. xvi., p. 397, May 2nd, 1885.

reflector, costing 1s. to 1s. 6d. By the bye, I designed that reflector.

As an improvement on existing arrangements of lighting, I do not think that these inventions will, by their distribution of the illumination, outweigh the expense of the glass, the cost of special frames or lanterns, and above all the difficulty of cleaning; but it remains to be seen whether by the use of this system three lamps may be made to do the work of four. That is a much more important matter; I used to claim that this could be done, and no one ever took the trouble to refute me. I am inclined to doubt the practical value of the German inventions recently described by Mr. Rankin Kennedy in these columns. Their aim is the same as far as distribution is concerned, but they do not combine diffusion with it, as in the present invention and in my own attempt. The practical difficulties seem to be far greater.

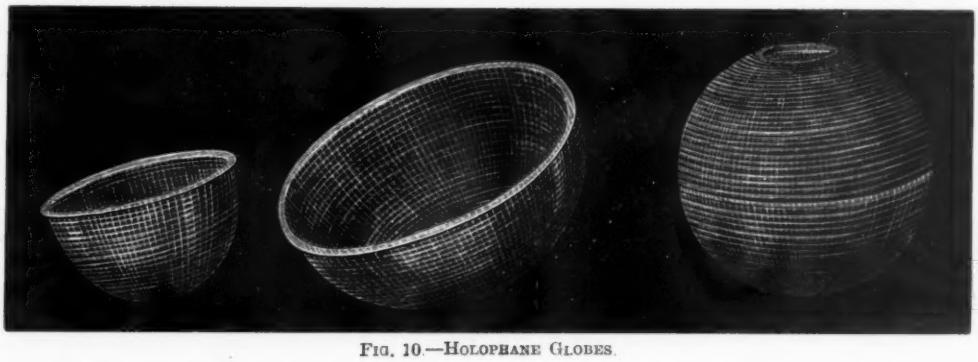


Fig. 10.—Holophane Globes.

Only a year or so ago I made a final attempt to apply this dioptric system in its most simple form to sheet glass for glazing alternate current arc lamps, with the object, not of attempting uniform distribution, but of deflecting the light, which is wasted upwards, towards the outer parts of the neighbourhood of the lamp. I intended to use convex and concave curves alternately, leaving no sharp edges or deep grooves, which are so difficult to clean, to make all necessary sacrifice to mathematical ideals in order that the ordinary steep inclination of the panes might be retained, and if possible to arrange that the glass could be rolled in large sheets, and cut up in the ordinary way. I made a proposal of this kind to an electrical manufacturing company, but was courteously informed in suitable language that they understood their business much better than I did; and, of course, they were right.

So far from wishing in any way to diminish the credit due to MM. Psaroudaki and Blondel, I only hope that any hints taken from my experience of this rather fascinating problem may be of use to them. I look forward to, and anxiously await, the success of their invention, for when it comes—and I will do all in my power to hasten it—I shall have the satisfaction of feeling that I was twelve years before my time.

HYSTERESIS.

In the discussion on the papers of Dr. Pupin and Mr. C. P. Steinmetz, read before the Philadelphia meeting of the American Institute of Electrical Engineers, and printed in the November number of the *Transactions*, Mr. Steinmetz refers, says the New York *Electrical World*, to the misconceptions in regard to the definition of hysteresis. He states that molecular magnetic friction is *not* identical with hysteresis, and defines magnetic hysteresis as the disproportionality between the magnetomotive force and magnetism, as the name signifies, which disproportionality is produced if upon an alternating magnetic circuit no energy is expended; since energy is consumed in the circuit by the molecular magnetic friction, this energy must be supplied from somewhere, and, in the absence of any other source of energy, is supplied by the magnetomotive force in the form of magnetic hysteresis. But this energy may be supplied by mechanical energy, and this is the case in smooth core machines, and then we may not find any hysteresis, or any disproportionality between magnetic field strength and magnetomotive force.

In a transformer the iron core is indeed set in vibration by the alternating magnetism, but this vibration, Mr. Steinmetz states, cannot supply the energy consumed by molecular friction and thus cannot eliminate magnetomotive force, and has the effect of intensifying the loss of energy—increasing the area of the hysteretic loop by the loss of energy in mechanical vibration, thus intensifying the higher harmonics, since now energy is expended not only by molecular magnetic friction, but also by mechanical vibration.

In another place Mr. Steinmetz states in regard to the loss of energy by magnetic friction in a rotary magnetic field, as for instance, in the revolving armature of a bipolar smooth core dynamo, that he found no essential difference than with the loss in an alternating field, but that occasionally the observed core loss in the armature of a machine is not the molecular magnetic friction only, but superimposed upon it are eddy current losses in the iron, the shields, &c., and in the conductors, which losses are proportional to the square of the magnetisation. Thus, the observed core loss sometimes rises with a power higher than 1·6, sometimes nearly approaching the square. But by laminating the iron very carefully, designing the mechanical construction so as to expose no solid metal to the alternating field, and shaping the conductors so as to exclude eddy currents, he always got curves very nearly proportional to the 1·6 power, up to very high magnetic densities (about B = 19,000). He thinks the law holds for generators just the same, and therefore believes the law applies, not to the hysteresis loss, but to the loss by molecular magnetic friction, since in the generators we probably have no hysteresis. Mr. Steinmetz states he took pains once to find out if there is a lag of the magnetism behind the resultant magnetising force in a generator which would distort the wave of electromotive force, but did not find anything of the kind. Thus the total loss of energy, which may be many kilowatts, may be supplied directly by the mechanical power, in which way he was not able to say, but not in the form of a hysteretic loop, at least, not a hysteretic loop of noticeable size.

In reply to Dr. Pupin Mr. Steinmetz stated that hysteresis has a well defined meaning. It was introduced merely to denote the lag of the magnetism behind the magnetomotive force, as the derivation of the word signifies, which lag causes the magnetism as a function of an alternating M.M.F. to describe a closed curve, the "loop of hysteresis." Afterward it was shown by Warburg and Ewing that the area of the hysteretic loop represents energy, and represents the energy expended by the magnetomotive force during the cycle of magnetism, and from this the erroneous conclusion has been drawn that this hysteretic energy is the energy lost in the iron by molecular magnetic friction, that is, by changing the magnetic state of the iron. Mr. Steinmetz asserts that this conclusion is wrong; that this energy expended by the magnetomotive force is not necessarily the energy wasted in the iron. The energy represented by the hysteretic loop or a part of it may be converted into mechanical motion, or the energy lost in molecular magnetic friction may be supplied by mechanical energy, and the hysteretic loop may collapse, or may expand considerably, so that between the area of the hysteretic loop and the loss of energy in the iron there is no direct relation.

DRAWING OFFICE APPLIANCES.*

By A. WELLS ROBINSON.

The following description of a drawing-board, easel, and blue print frame is presented to the society as furnishing simple and inexpensive examples of these items of office equipment.

The drawing-board shown in fig. 1 has a top 36 inches by

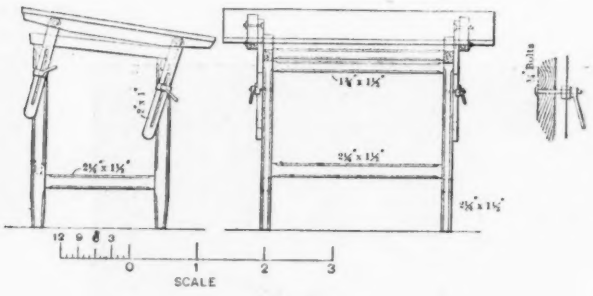


Fig. 1.

54 inches, glued up with saw cuts on the back in the usual way. It is of this size to suit standard sheets 23 inches by 36 inches, as described in paper No. 596, read June, 1894.† The top is made adjustable for slope and height by the slotted supports, as shown. This allows every draughtsman to suit himself in this regard. The lower frame and legs are of oak, neatly chamfered. These tables complete were made by a plain carpenter and cost $7.50 apiece.

Each draughtsman needs besides his board some convenient means of holding drawings for reference. The easel, fig. 2,

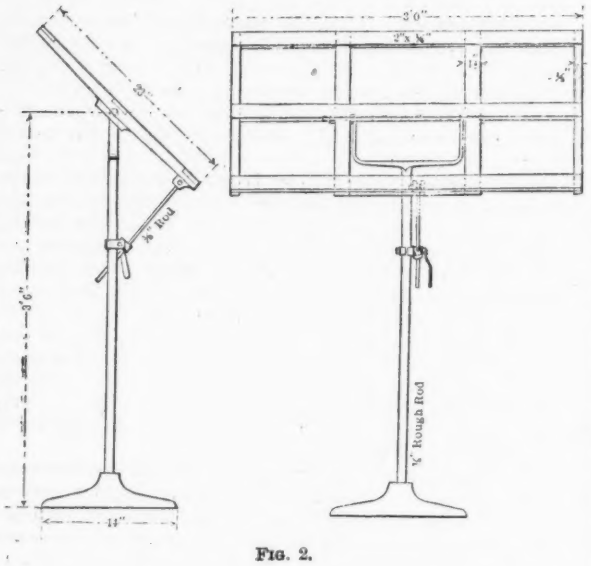


Fig. 2.

fills this need. A number of drawings can be attached to the top edge by spring clothes pins or clips, and turned over the back as required. This easel is also "home-made," and cost $6 each.

The blue print frame shown in fig. 3, is 25 inches by 38 inches inside. It is carried on two pairs of small grooved wheels attached to the side, and upon which it is reversible, as shown. The tightening of the back is done by three cross-bars pivoted at their centres. The ends of the bars engage with cleats screwed to the inside of frame at a slight angle, so that they wedge the bars to any desired pressure on the back. It is not considered necessary to provide for a double-swing support so that the surface of the frame can be brought normal to the sunlight. This undoubtedly allows of quicker printing during morning

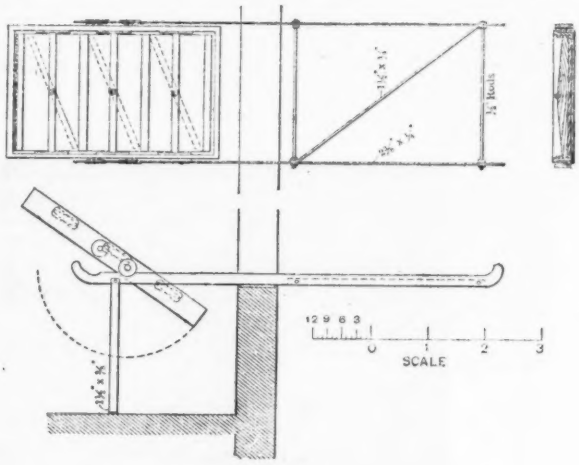


Fig. 3.

and evening hours; but the saving is not great, and is obtained at the expense of simplicity. This frame cost about $18, including iron track and plate glass three-eighths inch thick.

* Presented at the New York meeting, December, 1894, of the American Society of Mechanical Engineers, and forming part of Vol. xvi. of the *Transactions*.

† The relation of the Drawing Office to the Shop in Manufacturing: *Transactions* American Society Mechanical Engineers, Vol. xv., p. 965, No. 596. Published in Electrical Review, August 3rd, 1894.

THE GILGIT TELEGRAPH LINE.

Among the difficulties to be encountered when telegraph lines have to be constructed at high altitudes is, says the *Indian Engineer*, first of all the *cold*. The variation of the length of wire in a span owing to change of temperature has the effect of varying the strain, and unless precautions are taken the wire will merely break from the excessive strain due to contraction. It must, therefore, be erected at a tension not greater than one-sixth of its breaking strain, so as to allow an ample margin.

The next thing is *snow*, which affects a telegraph line in several ways. If the alignment be not judiciously chosen, the whole line, posts, wire and all, may be completely buried under the snow. Although *dry* snow is a bad conductor, and it is possible to send signals through a wire buried in it for a considerable distance, when the snow begins to melt the conditions change and the signals fail. Under any circumstances, it is an objectionable state of affairs, and one that has to be provided against. To this intent the site for each pole has to be carefully selected in order to avoid places where snow is likely to accumulate; where this is impracticable, specially long poles must be made use of.

On the Gilgit line two high passes have to be crossed—the Rajdiangan, 11,600 feet, and the Burzil, 13,500 feet. On the summit of the former snow sometimes lies to a depth of 10 to 14 feet, and on the latter 16 to 18 feet, and the poles used are 30 feet long. The poles need to be very strong, for the pressure of the snow upon them when planted on a slope is often very great. The use of stays or struts has to be avoided as much as possible, for experience has shown them to be a source of danger from the pressure exerted upon them by accumulation of snow. Moreover, when the ground is frozen hard, the post is so firmly fixed that provided it is strong enough, they are not wanted, especially when there is only one wire to be supported.

Another danger from snow is due to the fact that under certain conditions of the atmosphere it is deposited on the wire, forming a rope of snow several inches in diameter, until the line is broken down by the sheer weight of snow. *Dry* snow does not adhere; but when there is a change from rain to snow, or from a mild and moist to a cold and dry condi-

tion of the atmosphere, then it *does*. This is exemplified by the experience of last winter, when it was found that on the Rajdiangan Pass, which is affected by the moisture rising from the Woolar Lake, the snow formed on the wire, causing a break in one place; while on the Burzil Pass, which though much higher enjoys a *dry* climate, the snow did *not* adhere, and there was no breakdown.

The danger from wind pressure on a wire thickly coated with snow is greater than from the mere weight of snow. The effect of a high wind on a rope of snow is most disastrous, especially on a line carrying several wires. To guard against this danger on the Rajdiangan Pass, a solid homogeneous steel wire of the greatest strength manufactured has been put up over the most exposed section, supported on strong deodar poles, planted at short distances apart.

All these difficulties, and more, have had to be overcome on the Gilgit line.

With the best and most carefully constructed line, perfect immunity from damage in the winter can hardly be hoped for, and every possible provision for promptly restoring communication when an interruption occurs has to be made. To this end offices of observation are being maintained at Gurais and Minimarg, which, with those at Bandipur and Astor, command the two dangerous passes. In the winter there is absolutely no local labour procurable, and it is necessary to retain permanently sufficient men to form a strong party for interruption duty when required. Every man has to be fully rationed and supplied with warm clothes. Two Europeans are stationed at each office, and everything has been done that will help to render their services efficient, and their solitary life, during the months they are cut off by the closing of the passes, as bearable as possible. Each office has been supplied with different patterns of snow shoes, which it is confidently expected will prove of great value, when once the men become practised in their use.

Mr. H. S. Olphert is the telegraph officer who has been engaged in the construction of the Gilgit line, and it remains to be seen from the results of the coming winter whether his labours, and the care and forethought bestowed upon the work by the Telegraph Department, will be justified, and a reliable service maintained with this the most outlying portion of Her Majesty's Indian dominions.

WOODHOUSE AND RAWSON UNITED, LIMITED.

A MEETING of the debenture holders of Woodhouse & Rawson United, Limited, was held on Tuesday last, as recorded in another column. In the statement of affairs, of which an abstract was published in our issue of December 22nd last, it was stated that the net amount of liabilities on debentures was £160,854; and it was estimated that the assets would meet the liabilities on debentures and creditors, leaving a surplus of £29,636. In the very clear and business-like statement of Mr. Leslie, the Receiver for the debenture holders, it will be seen that he estimates the amount available for distribution amongst the debenture holders at £32,000, so that instead of there being a surplus for contributories the debenture holders themselves will only obtain a small dividend.

The company was registered on July 12th, 1889, and a winding up order was obtained on May 17th, 1893. The liabilities to contributories at that date were £477,959, to creditors £14,713, and to debenture holders £203,592. This gives a total liability of £696,264, and, after deducting the £32,000 estimated to be returned, leaves a net deficiency of £664,264. The company was in existence for four years, so that after making allowances for the amounts returned to the shareholders in the form of dividends, it may be estimated that the company lived on the loss of about £125,000 a year. It is clear from the evidence given before Mr. Registrar Hood, that in order to attain this result all the directors had given close attention to the affairs of the company, either personally or by deputy. The managing director especially had worked extremely hard and "the Board fully recognised that he had made great sacrifices in the interests of the company." As there was clearly no lack of management the collapse was generally attributed to a series of misfortunes, but as the Baring crisis and the consequent financial depression were the only ones specifically mentioned we must seek the others ourselves.

It seems to us that one misfortune of the company was that it started with great expectations; another that the firm whose name it bore had been in existence for some years, and had become known to the public as electrical engineers. Had it not been for these combined misfortunes, the company might now be doing useful work and paying reasonable dividends; but the great expectations had to be provided for. That is nothing unusual with companies. The promotion of other companies and the receipt of purchase considerations "fixed by the vendors," is not an unusual method of meeting great expectations either; but there was something unusual in the opportunities of Woodhouse and Rawson.

As electrical engineers, they were enabled to recommend particular "inventions." As promoters, they were enabled to profit by the formation of the companies whose wares they recommended. The managing director "altogether denied that Woodhouse & Rawson had ever been promoters in the ordinary sense of the word. They were not like the ordinary promoter, who brought out a new concern every month, and so long as he made a profit on it did not care what became of the company." Without realising any particular difference between the way in which the ordinary promoter and Woodhouse & Rawson would care what became of the company "so long as they made a profit on it," we are bound to admit the truth of the statement that Woodhouse & Rawson were not ordinary promoters. The ordinary promoter places his wares before the public as a promoter, and does not at the same time mislead them by pledging his reputation as an electrical expert. The ordinary promoter has generally had some experience, and is aware of the risky nature of his business. It was for these two reasons that as soon as we realised the promoting tendencies of the company, we set ourselves the task of exposing to the public the hollowness of Woodhouse & Rawson's electrical recommendations, and of warning the shareholders of the company of the risks which they were running. On July 4th, 1890, we criticised the prospectus of the International Okonite Co., and suggested to Woodhouse & Rawson that they should select one or other *rôle*—electrical supplies or company promotion—expressing our fear that they would find the combination not consistent with sound business on a permanent basis. It was elicited in the evidence before Mr. Registrar Hood that the profit of £37,000 on the promotion of the Okonite Company was included in the accounts to June 30th—although only realised at a subsequent date—because, in the words of Mr. F. L. Rawson, "it was a recognised rule that the profit on a contract should be credited at the date on which a contract was entered into." But this "recognised rule" was not adopted without the prop of "counsel's opinion"—a prop which seems to have been frequently in request. Throughout the company's career there has been apparently a disinclination to adopt a method of recording ascertained results, and a preference for a policy of make believe. For such a purpose "patents," "goodwill," and "securities," are far more useful in accounts than gold. Gold has a fixed value, but the "appreciation" of "securities," and similar items, can go on to any extent so long as somebody in authority can hold a sufficiently strong opinion on the subject. Thus the company presented a prosperous appearance whilst the work's manager "considered there was some difficulty in money matters throughout." The application of the necessary capital to the industrial branch of the business would probably not have produced dividends of 15 per cent., nor would it have led to an utter collapse in the short space of four years. We have not attempted to unravel the complicated thread of the relationship of the company with the Phœnix Trust and Baron Grant. It is difficult to see whether the relationship was a distant one or whether the company was a convenient alias for one of the most noted "ordinary promoters" of modern times.

Taking the history of the company as a whole, its management and its methods should serve some useful purpose if they are borne steadily in mind by the committee which is now in existence for the purpose of recommending reforms in our company laws. It is the policy of make-believe which is productive of so much evil. Itself an

embodiment of that policy, Woodhouse & Rawson United created numerous other companies which were founded on nothing else than "make-believe," and they persisted in exploiting those companies or their securities in spite of warnings based on technical knowledge, sound finance, and common sense. If the Woodhouse & Rawson promotions had been the creations of the ordinary promoter, the public would have been better off. The companies would have just died off naturally. It was the interest of the parent in the subsequent career of the offspring; the keeping alive on the policy of make-believe which led to additional losses and most reprehensible waste.

LIGHT RAILWAYS.

Board of Trade Conference.

Upon the invitation of the Board of Trade, a conference was held on Thursday, the 6th inst., at 8, Richmond Terrace, Whitehall, to discuss the desirability of providing light railways in districts now unprovided with means of transport. The Right Hon. James Bryce, President of the Board of Trade, occupied the chair, and with him were Mr. Herbert Gardner (President of the Board of Agriculture), Mr. Burt (Parliamentary Secretary to the Board of Trade), Mr. Shaw Lefevre (President of the Local Government Board), Sir Courtenay Boyle (Permanent Secretary to the Board of Trade), Mr. F. J. S. Hopwood (Assistant-Secretary, Railway Department), Major Cardew (Electrical Department), and General Hutchinson, Major Marindin, Major Yorke, and Major Addison (Railway and Tramway Inspectors of the Board of Trade). There were also present: The Duke of Sutherland, Major Rasch, M.P., Mr. Storey, M.P., Mr. W. M. Acworth, Sir Jacob Wilson, and the following representatives of various bodies:—London County Council—Rev. Fleming Williams, Mr. Bruce, Mr. Beachcroft; Association of Chambers of Commerce—Sir Albert Rollit, M.P., Sir Bernhard Samuelson, M.P., Sir Alfred Hickman, M.P., Mr. F. Corbett; Central and Associated Chambers of Agriculture—Mr. Channing, M.P., Mr. Jeffreys, M.P., Mr. R. H. Rew; London Chamber of Commerce—Sir Edward Carbutt, Mr. E. Garcke; Railway Companies' Association—Lord Claud Hamilton, Mr. J. C. Bolton, Mr. W. L. Jackson, M.P.; Institution of Civil Engineers—Sir Benjamin Baker, Sir Douglas Fox; Association of Municipal Corporations—Mr. Alderman Brownsword, Mr. Harcourt Clare, Mr. G. C. Kent; Association of County Councils—Lord Edmond Fitzmaurice, Mr. Henry Hobhouse, M.P.; Surveyors' Institution—Mr. E. P. Squarey, Mr. C. Oakley; Tramways Institute of Great Britain and Ireland—Mr. Carruthers Wain; Mansion House Association on Railway and Canal Traffic—Mr. Tomlinson, M.P.; Institution of Electrical Engineers—Mr. Alexander Siemens, Major-General Webber, C.B.; Royal Agricultural Society of Engineers—Earl Cathcart, Mr. W. Frankish, Mr. Ernest Clarke; National Traction Engine Owners' and Users' Association—Mr. R. W. Eddison. Scotland was represented at the conference by Bailie Sloan for the Corporation of Edinburgh, Mr. A. Beveridge for the Convention of Royal and Parliamentary Burghs of Scotland, and Mr. Guthrie Smith, representing the Scottish Chamber of Agriculture. The Right Hon. A. J. Balfour, M.P., Mr. H. Chaplin, M.P., and Sir Michael Hicks-Beach, M.P., were unfortunately prevented from attending the conference. Lord Thring, Mr. Mundella, M.P., Lord Farrer, and Sir J. Whitehead, M.P., were prevented by illness from attending the conference.

Mr. Bryce said the motives which had induced him to call the conference had been chiefly these: There had been of late years a very severe depression in our agricultural districts, a depression with which he sympathised, and which led them to look for any possible remedy or palliatives that could possibly be applied. It had been said that among those remedies would be the opening up of more abundant means of communication through the rural districts. In many foreign countries, and, notably, in Belgium, Italy, and France, there had been of late years a large development of communication through rural districts made upon a cheaper, simpler plan than that which had been applied to the trunk lines of those countries. In travelling through France and Italy, soon after he took office, he was much struck with the extent to which those cheap lines had been developed in districts even with no great population, but where, nevertheless, they appeared to be stimulating traffic, both in passengers and freight, which held out a hope of being remunerative to those who had constructed the lines. Those present could not have failed to be struck with the fact that, though 50 years had passed since most of the trunk lines had been constructed, comparatively little had been done of late years to extend the facilities of locomotion to the less populous country districts. It was quite true that the work of construction had gone on, and, he believed, since 1868 the total railway mileage of the country had increased by 40 per cent. Although in 1868 people supposed that what had been done by railways of the normal plan had almost come to an end, yet when they looked at the enormous progress which applied science had made within the last 40 or 50 years, it might be felt that not so much had been done as might have been expected to provide for what he might call the minor and local needs of locomotion, and, above all, for the conveyance of produce. They ought now to set themselves, therefore, to consider whether, after the progress science had made, something might not be done to remedy those deficiencies. There had been lately an increasing evident desire on the part of the public that facilities of the kind he had indicated should be afforded. In some quarters there had prevailed an idea that the Board of Trade was a little reluctant to enter upon a new policy, and, perhaps, even showed a little indifference to what the demands of the people had become. Speaking not for himself, but for the Board of Trade—under the guidance of successive ministers, and especially for the permanent officials in whose hands the railway policy lay—there had never been any indifference on their part when there had been any want or desire which public opinion could demand. He must point out that a department such as this was pledged in many respects to keep only just ahead of public opinion. They were restricted in their railway policy in many points by statutes, and in many other points by an usage which public opinion had sanctioned. They could not go far in advance of what public opinion, under the statute, required; and if public opinion required the department to maintain a high standard of safety and public convenience, they could not without the authorisation of Parliament, and without the support of public opinion, undertake to sanction anything which would supply a lower standard. That was one of the principal reasons why the department asked those present, whom they believed to be representatives of public opinion in this country, to come into counsel with them and give their views as to the extent to which public opinion would support the Board of Trade in proposing the relaxation of its present requirements in any varying of policy hitherto followed. The problem seemed to have two sides. There was the agricultural side and the side which related to congested population. On the agricultural side the question was—"Are railroads needed in our rural districts, and can they be made to pay? Can they be constructed to reduce the cost of transportation, especially for farming produce, to facilitate the supplies of food to the great centres of population? and can they enable the British farmer to compete better with those who supplied food, and in particular dairy produce, in other countries?" It could not have failed to strike them as being singular that so many dairy products were imported from Denmark and other continental countries. If the cost of transport was an element which enabled those producers to compete with us, then it was an element which we ought to try to reduce, and, if possible, extinguish. The other side of the problem related to the urban population. Was it possible to relieve the congestion of our great cities, either by providing better transport for workmen to their work from suburban areas, or in enabling industries now conducted in cities to be transferred to suburban or rural districts by providing easier and cheaper modes of transport? That seemed to him to be a problem whose solution might have beneficial results, not only on industry, but on the health and well-being of the community. He believed that railroads would certainly be made if they could be made more cheaply, and the question he had to present came to be mainly a question of money. The cost of our present lines was very high, and from two causes. The first was the obtaining an Act under which railroads might be made, and the other cause was the making and working of the line. Could they reduce those two elements of cost? He supposed it would not be vanity for them to say that the English roads were the best in the world, if they looked both at speed and safety, and the amount of comfort and convenience afforded. But they were also the costliest in the world. It was perfectly clear that if they continue to maintain what they had been accustomed to think necessary for their present normal lines, they could not very much reduce the cost of creating them. They must be content to drop something of what they had been accustomed to enjoy, something in speed, something in safety, something in comfort, as it related to passengers and convenience, as it related to the transport of goods. Why was it that our railroads were so exceptionally safe? If they compared our system with that of the United States, it would be found that the percentage of accidents was very much lower in England than in America. The reason was that we were very careful about the fencing of our lines, about requiring adequate platforms to be provided, and the Board of Trade was constantly remonstrating with companies, requiring them to provide a more complete service of platforms for convenience and safety. We had also an elaborate system of signalling; there was also the continuous brake, and they insisted on the substitution of bridges or otherwise for level crossings; and when there was a level crossing they required a man to be maintained to look after the gate. All those points might, in a sense, be regarded as luxuries; they were things without which a railway could exist. But safety was a most important element, though railways could be worked without some of these things and without having others in a more perfect state than they had been accustomed to require. If they were content to dispense with all, or with some of those things, railroads could be made cheaper. If, for instance, they dispensed with stations and allowed crossings to be kept where bridges would otherwise be, and if they would allow a crossing without a man to look after it, the expense of working a railway would be reduced. It would now be extremely hard to reduce the mere expenses of constructing a normal railway, taking into consideration the land and Parliamentary expenses, below an average of £10,000 a mile, whereas there was reason to believe that what was commonly called a light or cheap railway might be made at a cost variously estimated at from £2,000 to £4,000 a mile. Of course, this cost became far greater if they took the railways as they stood. If they took all the railways in the United Kingdom, the total cost would be not less than £50,000 per mile, counting every element of expense. He must not conceal from the meeting that if they were to dispense with many of the requirements hitherto enforced, there might be more accidents than now. He believed that the adoption of a low rate of speed would greatly diminish the chance of accidents. It was true that the populations among whom a railroad ran very soon learned to accustom themselves to the absence of safeguards on which they had depended, as seen in the United States. But this was a point on which the Board of Trade must follow, and not

attempt to lead public opinion. If accidents arose on those cheap railways due to the absence of those safety requirements hitherto enforced, complaints would immediately be raised against the Board of Trade, and in particular against those gentlemen who had very difficult and responsible functions to discharge, functions which they discharged with great care and conscientiousness—he meant the inspecting officers. There was a case in which the coroner's jury returned a verdict of manslaughter against an inspecting officer because he had shown too much leniency in allowing a railway to be opened for traffic too soon. Public opinion must face this side of the problem, and the Legislature must give them some authority on the matter. He thought, also, that local authorities, who, he feared, in some instances, had not been as favourable as they might have been to those promoting cheap railways, must make up their minds to change their attitude on these points. They must be content to face those chances if they wanted the benefit of cheap railroads. There was also the cost of taking land. Inquiry before a Parliamentary committee was a very costly affair, so costly as to be practically prohibitive to small undertakings. The question, then, was, whether they might not be content to allow some authority less expensive than Parliamentary committees had proved to be to give powers for making railways. Whether that authority should be the local authority, such as the County Council, whether a department of the Government, such as the Board of Trade, should be associated, what should be the respective parts to be played by the local authority and the Board of Trade, were questions on which he should be glad to have an expression of opinion. He would indicate what he thought were the main heads to which the debate might be directed. In the first place, was the need for cheap railways a real one, and whether a considerable traffic might be expected which would make those undertakings, if cheaply constructed, remunerative to the shareholders? If that question were answered in the affirmative, it would open the way to the discussion of some technical questions. First of all there was the question of the gauge, and the motive power to be employed. It would not be well to spend much time in discussing the question of gauge, important as it was, or the question of motive power. Those questions were best left to those who in any particular case desired to promote a particular cheap railway. There were cases in which the present normal gauge would obviously be the best; there were cases, such as hilly countries, or where a railway was not wanted as a through line, where there might be a stronger case for having a narrower gauge. It was necessary to leave, therefore, considerable latitude to those who proposed any particular scheme. Then there was the question of the requirements which it was thought the Board of Trade might properly dispense with—the requirements of construction and working, including the question of fencing, signalling, the block system, crossings *versus* bridges, station accommodation, platforms, and the maximum of speed. It would then be necessary to consider the question of requirements in their application to two classes of cases. First, to the case of sparsely peopled districts, where evidently a somewhat laxer scale of requirements might be adopted; and the case of suburban or densely populated districts, where obviously the question of safety would have to be of a higher order. Besides, there were a group of questions which he might call political or economical. Who should grant the power to take land compulsorily? Who should settle the route which the railway should adopt in case it was opposed by anyone holding land along the line? There might be the question as to the basis of compensation to persons whose land was taken. There was the very important question whether the local authority should have the power to make a cheap railway or aid in the making of it; and if it should have the power, whether that power should be given it under the form of enabling it to make and own the line, or to lease it, or guarantee a minimum dividend, and whether there should be a power reserved for the ultimate acquisition by the local authority. Lastly, there was the group of what he called mixed or miscellaneous questions, such as what relation those cheap railways ought to bear to existing railways; what arrangements ought to be made for the connection of them with existing lines; whether rules were to be imposed with regard to through booking; whether the rates to be charged should be fixed on the system of maximum, and whether the scale fixed on the present lines should be taken as the point of departure for settling the scale to be fixed on the new lines. He hoped that the existing railways would recognise the great value which those new lines might have for them. They would serve as feeders; probably in many cases they would develop a traffic which did not now exist, both passenger and freight, and he thought they would be found to increase, if properly used, the prosperity and the dividend-paying power of the present lines. So far as their present information went, the existing railway companies regarded this movement with friendliness, and he hoped some expression of opinion would be heard from them of the view they took of the problem as it appeared from their point of view. There was one question outside the scope of their deliberations—the question as to any aid by the central Treasury of the country. He conceived that it was not a question fit for discussion in that place. He held a strong opinion upon it, and it was one on which he believed the mind of Parliament was absolutely settled, and they would not be spending their time to good purpose if they were to discuss a subject which was not likely to bear any good fruit. The objections to such a policy in a country like this, and in the present state of our revenue, had, in view of the competition which would at once arise in many parts of the country for such State aid, as well as the results which had followed from it in many of our colonies and in the United States, convinced them that it was a question they need not attempt to consider. He hoped that the discussion would be practical, and that it would converge on the questions which were at present important as to what legislation was wanted. He believed that there was a real need existing for cheaper and more extensive means of communication, and he believed the enterprise of creating those communications would pay if the lines could be made at a lower rate of cost than at present. He concluded by stating that a sub-committee of the conference would be appointed to consider the whole question, and to draw up a report with the view of legislation being founded upon it.

Lord Edmond Fitzmaurice was the first to speak in the discussion which followed Mr. Bryce's statement. He dwelt upon the importance of such new light railways as might be constructed, and for which there is undoubtedly a large sphere of usefulness, being worked in connection with existing railways. What was essentially desirable was that the great railway companies should co-operate, and offer facilities for the making of junctions between the light railways and the existing lines, so that agricultural produce might the more easily reach the main lines, and unless something of this kind was effected, a new line might soon find itself ruined. But in order that there might be the requisite inducement for the railway companies to take steps in this direction, the Board of Trade ought to try, either by arrangement or by positive legislation, to extend the powers of the Railway Commissioners, in order that those who might embark capital in a light railway might have some security that their money would not be thrown away in consequence of the opposition of the existing railway companies.

Mr. Henry Hobhouse, M.P., said light railways might become of the greatest service in developing the industries of remote districts, and in enabling agriculturists to more cheaply and expeditiously find a market for their produce. But the first question to be considered was one of cost. Although admitting their possibilities of usefulness, ratepayers would certainly object to the imposition of any very heavy burdens on the rates for the purpose of constructing them. With regard to the compulsory acquisition of land, public enquiry and discussion were essential, and such enquiry should be conducted locally, rather than at Westminster.

Lord Cathcart was inclined to think that the transport of agricultural produce alone was scarcely likely to make a line pay, and thought it would be necessary to make provision for a considerable passenger traffic as well. He was in favour, however, of the experiment of constructing light lines being made, and desired that every possible freedom should be allowed in the working of those lines. The great danger which lay ahead was in regard to compulsory powers, and he was afraid that was the rock upon which the whole scheme would split, unless there was a sufficient court of appeal, not only for landlords, but for tenants, and for all who might be affected.

Mr. Humphreys Owen, M.P., was strongly in favour of powers being given to local authorities to make guarantees, and thought that unless that were done, there would be slight chance of the requisite capital being raised.

Mr. Channing, M.P., also spoke of the extreme value of light railways in agricultural districts. There was no reason why there should not be actual connection in this way between the farmyards and the main lines of railway, to which the lighter lines would act as valuable feeders. It was absolutely essential, however, that the rates should be as low as possible, for whilst the considerations of time-saving and convenience were of great importance, the inducement would not be so much desired as to outweigh the consideration of expense.

Mr. Jeffreys, M.P., said if light railways were constructed, the cost of their formation should not fall in any way upon the rates, and he protested against the suggestion that money should be advanced or guaranteed by the county councils. The money should come either from private enterprise or from the Imperial Exchequer, as in the case of Ireland.

Mr. Samuel Storey, M.P., said the Parliamentary Select Committee was satisfied that light railways would be of very great advantage to many parts of the country. They ought to enlist the support and the action of the local authorities, and give them extended powers. Local authorities should be in a position to refuse consent to any projected line of railway in their district unless a public enquiry had agreed to its being satisfactory. Much fuller powers were required for the acquisition of land cheaply, and he thought they (the local authorities) should have the power to pledge the rates in order to secure the creation of light railways.

The Duke of Sutherland endorsed the view expressed by Lord E. Fitzmaurice that the light railways should be worked as feeders by the great companies, which ought to be encouraged by the Board of Trade to work them. In the Highlands of Scotland the great necessity for light railways was recognised, and the poor people there subscribed in small sums towards the cost of making the lines.

Mr. James Long, of the Dairy Farmers' Association, Mr. Clare, Town Clerk of Liverpool, and Mr. Kent, Town Clerk of Longton, all advocated the construction of light railways, and contended for increased powers for local authorities and the relaxation of the Board of Trade regulations. The Rev. Fleming Williams alluded to the interest taken in the subject by the London County Council as affecting their policy of re-housing the poor.

Sir Albert Rollit said the State and the locality should co-operate to construct light railways, supplemented by private enterprise.

Mr. Dodd, Q.C., M.P., said the legal expenses of taking land compulsorily should be reduced. Application with regard to a tramway should, in the first instance, be made to the County Council, and then the matter should be brought before the Board of Trade, who should hold an enquiry.

Sir Alfred Hickman, M.P., was in favour of the Board of Trade as the tribunal in regard to the construction of railways rather than the County Council.

Lord Claud Hamilton said the Great Eastern Railway viewed with favour the general principle of railway extension by means of subsidiary lines, but they wished to have something presented to them in a more concrete and definite form before they pledged themselves to any opinion upon it.

Mr. Bolton thought that if light railways were to be constructed, they should conform to the standard gauge. The railway companies looked with great sympathy on this proposal, and were desirous of lending any aid in their power to carry out the object in view.

Major Rasch, M.P., thought the special needs of agricultural districts would be better served by steam tramways, to run along the roads, than by any more costly form of construction.

After an adjournment for luncheon, Mr. Bryce suggested that it would be well to elect a committee at once, and upon the motion of the Duke of Sunderland, the following gentlemen were appointed:—Sir Michael Hicks-Beach, Sir Bernhard Samuelson, Sir Alfred Hickman, Mr. W. L. Jackson, Mr. Beachcroft, Lord Claud Hamilton (Colonel Makins to act in his absence), Lord Cathcart, Sir Courtenay Boyle, Mr. Hopwood, Lord Thring, Mr. Walter Meik, Mr. H. Hobhouse, Mr. W. M. Acworth, Mr. Samuel Storey, Mr. Humphreys Owen, Sir Benjamin Baker, Sir Alexander Rendel, Sir Andrew Clarke, Mr. Alexander Siemens, Lord Edmond Fitzmaurice, Mr. Stephen Sellon, Mr. Channing, Sir Albert Rollit, Mr. Carruthers Wain, and the Duke of Sutherland. It was agreed that the report of the committee should be presented to the conference by the last week in January.

Sir Bernhard Samuelson asked what the Board of Trade was prepared to lay before the committee. There was a great deal of information upon the subject scattered about throughout the Continent, and if they left that to be obtained by our representatives abroad, the value of it would not be so great. It was very desirable that that information should be obtained, even if in the interval some members of the committee went to the Continent specially for the purpose. The information they desired was more especially in regard to the various modes in which light railways and tramways had been tested in various countries.

Mr. Bryce said some weeks ago one of the inspecting officers was sent to the Continent to obtain facts and make reports. The information had been obtained, and papers relating to Belgium would be put into their hands. If that were not sufficient, it would be perfectly easy to procure additional information, but he believed they already had in their possession sufficient information to satisfy the needs of the committee. All the information which the Board of Trade possessed would, of course, be entirely at the disposal of the committee.

Mr. W. L. Jackson, M.P., then resumed the discussion by giving the results of his observations regarding the construction of light railways in Ireland during the period of Mr. A. J. Balfour's chief secretaryship. Most of the light railways in Ireland had been constructed under what were known as baronial guarantees, and in many cases the charge now made upon the barony was felt to be a great burden, and the ratepayers were more or less restive under it. The general opinion he had formed was, that wherever they could as conveniently make arrangements under which the lines to be constructed might be worked in connection with, and by the adjoining, or what they might call the parent company, that arrangement would result both in economy and in the most useful development of the system. One important thing to be borne in mind was, if possible, to avoid laying any charge upon the district, but if they did lay any charge at all, to define and limit that charge.

General Sankey gave some details of the construction and working of narrow-gauge lines in Ireland.

Sir E. Carbutt spoke of the necessity of dispensing with special Acts of Parliament and the reduction of legal expenses generally in connection with new railways. He thought a roving commission, such as that in operation in Scotland, might be of material assistance in holding inquiries. Upon the question of speed, he understood that they could not run tramways at a greater speed than eight miles an hour. In America he had often travelled on the old cable lines at the rate of 14 miles an hour. Those lines were now being rapidly converted into electric systems, which system he believed now formed 50 per cent. of the whole of the tramway lines in America. There, they considered, that if they had a tramway at all, they must have some speed. The Committee of the London Chamber of Commerce, whom he represented, wished him to say that the Board of Trade ought to permit a speed of from 20 to 25 miles an hour in the fields, and from 10 to 12 in the roads. His experience with regard to gauge was, that it would be better in cases where they had a long lead, to have a narrow gauge, but if there was only a short lead of 15 or 20 miles, then by all means make it the gauge of the country, 4 feet 8½ inches. He thought it was advisable to have as heavy a rail as possible. The difference of cost was so slight, whilst the cost of working with a light rail was so much greater, that the London Chamber of Commerce were strongly in favour of a heavy rail.

Mr. Emile Garcke spoke upon the subjects of Parliamentary procedure in regard to railways and the compulsory acquisition of land, urging that greater simplification was necessary in both regards.

Sir Douglas Fox also advocated the simplification generally of the means of obtaining powers for constructing light railways. He was not in favour, however, of any increase of speed. A great many regulations would become necessary on lines worked at a speed of 25 miles an hour which would not be necessary with a speed of 12 miles an hour. Light lines were laid along military roads in Italy, and were of the greatest benefit to the farmers, taking their produce from their very gates; but these lines cost £2,500 a mile to construct, and had not proved remunerative. They would find in England very great difficulty in laying railways satisfactorily to run along the public roads. It might be done to some extent in Essex and other flat parts of the country, but they could not contemplate many auxiliary railways laid on the public roads. With regard to the question of gauge, they wanted freedom, but at the same time it was undesirable that the country should have gauges scattered all over it of different kinds. Still the introduction of narrow gauge for railways of considerable length had been a very great benefit, and there was a great saving to be made by introducing a totally different system of rolling stock and construction from that in vogue on the normal gauge, and he was glad to hear Mr. Bryce say that the matter ought to be relegated to a legislative body to deal with each case as it stood. He was quite sure if the matter were simplified as regards legislation, and if they were enabled in the proper places to make use of the tractive power of electricity, there was a great future for light and cheap railways.

Mr. Arthur Bain gave some particulars regarding the Southwold line, which ran under very friendly relations with the Great Eastern Railway. That line was carried out on a 3 feet gauge, because they could not get money to do it in any other way. It had admirably answered its purpose, and overtures were now being made for its purchase by the Great Eastern Railway Company. Light railways, in his opinion, should not be made unless the cost could be cut down to the lowest figure in every possible way. It had been suggested that the great thing for the promoters of light railways to do was to go to the main line companies. His experience of 20 years was to a totally contrary effect, and his opinion was that if they wanted the light lines to prosper, they should break the gauge.

Mr. W. M. Acworth advocated the relaxation of the Board of Trade regulations in regard to speed and other matters.

Mr. Carruthers Wain pointed out how disadvantageous to those who financed tramway and other similar companies which gave local authorities the right to acquire the undertakings at the expiration of a certain period, and said some change in this respect was necessary if there was to be any extension of lines of the kind. As a matter of fact, there were fewer miles of tramway working in this country now than there were four years ago.

Mr. Corbett, Mr. Squarey, and Mr. Jeans having spoken,

Mr. Bryce said they had had a discussion which had been both interesting and instructive. A great many points had been raised which the committee appointed would find it desirable to discuss, and a good deal of what had been said would be found to suggest matter for inquiry to the committee. He hoped that those who possessed knowledge which would be of value upon the subject would give their information to the committee when applied to for it. He also recognised with great satisfaction that the tone of the discussion had been generally sympathetic towards the projects they had been considering, and in many cases exceedingly hopeful. He was particularly glad to find that existing railways were disposed to look upon the movement with sympathy and with hopefulness He desired on behalf of the Board of Trade to thank the gentlemen who had spoken for the consideration shown for the difficulties under which the department laboured. In thanking them for the valuable help they had given as affording by their utterances an index of the movement of public opinion, he would suggest what struck him as the best way of turning their meeting to account, and that was that the committee, as soon as it had concluded its labours, should inform him that its report was ready, when he would call that conference together again and the report might be presented to it, so that they might base any resolutions upon it which they might think necessary as an indication of the views they entertained, and as a guide to public opinion as to what was desirable in the way of legislation.

A vote of thanks having been passed to Mr. Bryce, the proceedings terminated.

LEGAL.

Gordon & Co. *v.* Scottish House-to-House Electricity Co.

In the Queen's Bench Division of the High Court of Justice, on Friday the 7th inst., this matter came before Mr. Justice Lawrence. The plaintiffs' claim was originally for the sum of £7,100 alleged to be due from the defendants as follows:—(1.) Payment of £5,000 under a contract dated November, 1892. (2.) Payment of £600 advanced by the plaintiffs to the defendants. (3.) Payment of £1,500 certified by defendants to be due in respect of work done by the plaintiffs. Counsel, however, explained that the last two claims had been abandoned.

Mr. Jelf, Q.C., and Mr. Willis Bund appeared for the plaintiffs; Mr. Crump, Q.C., and Mr. Terrell for the defendants.

The plaintiffs' case was that they were a company duly registered in England, and formerly carried on business as electrical contractors and engineers, but now in voluntary liquidation, and the leave of the court had been obtained to commence this action. The defendant company was a company similarly registered, their registered office being 14, Sherborne Lane, King William Street, London. On the 24th October, 1892, a contract was duly made and entered into between the defendant company and the plaintiff company, whereby the plaintiff company were appointed sole contractors to conduct certain works on certain terms, and under such contract the plaintiff company became entitled to recover £5,000 and other sums. No payment had been made by the defendant company to the plaintiff company under the contract, and the defendants refused to pay the sums on demand. Hence the action.

The defence admitted the agreement, but said that the alleged contract contained only part of an agreement made between the plaintiffs and defendants and others for finding the necessary capital to take and carry through a provisional order under the Electric Lighting Acts for supplying the burgh of Coatbridge with electricity, by which arrangement Messrs. Macleod, Eisler, Marshall & Morrison undertook to underwrite a number of shares in the defendant company, and the plaintiffs undertook to execute the necessary works, payment for which was to be made to them out of the moneys so provided, and the plaintiffs also undertook to pay commission to these persons for underwriting the shares out of the first moneys receivable by them. Under the circumstances the defendants contended that the con-

tract was conditional upon the carrying out by the persons of their obligations to underwrite the shares, which they never did, while the plaintiffs were ready and willing to complete the contract. Counsel for the defendants also contended that the plaintiffs had suffered no damage.

Mr. Justice Lawrence held that the defendants were not liable to pay the £5,000, and entered judgment for them, with costs.

Hall Electrical Company v. Lewis.

At the Liverpool County Court the other day an action was heard, in which Messrs. E. Lewis & Sons, Wolverhampton, appeared as the execution creditors; Messrs. A. Hall & Co., electrical engineers, Liverpool, as the defendants, and the Hall Electrical Company, Liverpool, as the claimants.

Mr. Tobin, for the claimants, stated that Mr. J. L. Barnacle had been carrying on business as an electrical engineer, under the title of A. Hall & Co, and in October last, more capital being required, a limited liability company was formed, a number of shares being transferred to Mr. Barnacle for his interest in the business. Subsequently an execution was put in, and the question at issue was as to whether the company were or were not the owners of the goods. He contended the company were the owners under agreements entered into. Mr. Barnacle gave evidence regarding the transactions that had taken place, and denied that the company had been formed for the express purpose of preventing executions being levied. Most of the signatories to the articles of association were their workmen, but he could not say that their shares were presented to them.

A legal point having been raised, Mr. Wall, for the execution creditors, asked that the case should be completed before arguments were taken, with a view to other proceedings. Mr. Tobin withdrew his claim and the costs of the sheriff were allowed from money paid into court.

CORRESPONDENCE.

Woking Electric Lighting.

We see in your issue of to-day, under the heading "Woking," that you say the lights were out one night last week for two hours. As proprietors of the Woking Electric Supply Company, may we ask you to be good enough to correct this. Owing to the sudden failure of one of the Mordey alternators while our full load was on, we were compelled to cut off one circuit until the load on the others was reduced. We have had a rapidly increasing demand for current during the last few months, and, with the street lighting just commenced, have as much as our machinery can do until new plant, ordered six months ago, is delivered, and this we are promised before the end of the month.

Pp **New & Mayne,**
Edward Mann.

Wanted: A Speed Indicator.

Can you tell me if there is such an instrument as I describe below, and if there is not may I suggest it to manufacturers, through the medium of your journal, as likely to be appreciated by many who like myself are responsible for the correct speed of machines.

A portable revolution counter of the Harding's or similar type, combined with a watch or minute chronometer—preferably non-magnetic—in such a way that directly pressure is put upon the counter spindle it releases the mechanism for counting one minute (or more or less according to adjustment at will), and at the same time commences recording revolutions in the usual way until the exact minute is up, when it is automatically tripped out of gear (or stopped earlier of course if withdrawn from the running shaft).

Many will doubtless appreciate with me the difficulty of watching the second's hand of a watch when a stop watch is not available, and at the precise moment to hit the centre of running shaft with ordinary counter.

H. Dudley Barlow.

Paisley, N.B., *December 7th*, 1894.

Electric Lighting at Folkestone.

Instead of responding to my challenge which appeared in your issue of the 9th ult., Mr. Francis Hastings Medhurst has endeavoured to beg the question by sending me a most extraordinary letter, which, together with my reply thereto, I append herewith. Mr. Medhurst is not the man to allow a false imputation to be cast upon his professional status or character without a murmur, and under these circumstances there is no other possible alternative than to assume that the various representations to which I drew attention, are absolutely unwarranted.

With reference to Mr. Medhurst's letter, I beg to submit the following observations:—

1. Without the slightest provocation Mr. Medhurst made a most unwarrantable attack upon me in your issue of the 2nd ult. When *forced* to admit his error, surely it behoved him to make a public acknowledgment of the same in your columns, instead of writing to me under cover.

2. Mr. Medhurst's remarks relative to personal feeling are absurd and childish in the extreme. There is not the slightest possibility of mistaking his real motive, and with his object in view he has adopted most reprehensible means to discredit both myself and my work in the sight of my employers.

3. Mr. Medhurst's opinion relative to my recommendations to the Folkestone Corporation are uncalled for, and are absolutely valueless. I am, however, quite willing, and have actually suggested, that the said proposals should be submitted to someone whose position as an experienced electrical engineer is beyond question—say, Prof. Kennedy, Mr. W. H. Preece, or Mr. E. Manville. It is almost needless to say that I not only object to, but most strongly protest against my work being condemned upon the misrepresentations of one who is apparently a mere novice, and whose sole object seems to be to get himself installed as "consulting electrical engineer" to the Corporation of Folkestone.

4. I do not agree with Mr. Medhurst's belief that the Corporation of Folkestone will adopt his report and establish electric lighting works at a cost of £12,000 or £15,000. The present position of affairs at Folkestone, which is certainly without a parallel in the history of electric lighting in this country, is entirely due to the misrepresentations of facts. What the ultimate result will be, one can easily guess. I must also add that there is nothing whatever in the proposals which I laid before the original electric lighting committee to prevent me carrying out a scheme such as Mr. Medhurst suggests, if it is really desired. In reply to an interrogation, I informed the committee that it would be possible to commence electric lighting operations with a capital expenditure of £10,000, but advised that £20,000 should be the minimum. I prepared some five or six distinct schemes for the information and guidance of the committee, one of which involved a capital outlay of £25,000. The £35,000 scheme which *was eventually adopted by the corporation*, was selected by the committee after careful and prolonged consideration, as being the best suited to meet the present as well as the future requirements of Folkestone. That the decision was a wise one, viewed from a *practical engineering and commercial point of view*, there is not the slightest doubt; but if the corporation is determined to embark upon a smaller scheme, I am quite prepared to carry out their wishes, without Mr. Medhurst's interference.

5. The suggestion which Mr. Medhurst makes with reference to co-operation is most significant, and will doubtless be duly appreciated by your readers, without the addition of any comment from me.

Mark Parker.

Rochester, *December 11th*, 1894.

Westminster Chambers, 13, Victoria Street,
London, *November 13th*, 1894.

Folkestone Electric Lighting.

Dear Sir,—I have no doubt that you will be not a little surprised to hear from me with reference to the above.

I am really writing to assure you that until I saw your letter in the Electrical Review last week, I was quite unaware that you had the standing experience that your statements indicate.

You cannot fail to believe that in this whole matter I have not been actuated by any personal feeling or antipathy towards you, for, as you know, we have never met, and I had never heard your name mentioned until I began to take an interest in Folkestone electric lighting matters.

I hear from my friend . . . . . in a letter received this morning, that you have "been a hard working electrical man for many years," and as this confirms your own statements in the Electrical Review, I am forced to admit their correctness.

Under the circumstances I feel that I should be doing a distinctly ungenerous action were I to pursue this Folkestone business absolutely independently, and without any concern for your interests. I honestly believe that my report will be accepted by the corporation

and that a scheme of electric lighting is likely to be carried out at Folkestone at a cost of from £12,000 to £15,000. I may say, further, that in my opinion, it would be unwise for the corporation to incur, initially at any rate, a larger expenditure, and I am convinced that the £35,000 scheme you recommended the corporation to adopt contained very many fallacious assumptions, and would certainly have incurred a considerable working loss, which could only have been met by an increase to the rates for some years to come.

Nevertheless, I recognise that you have taken a great deal of trouble over this Folkestone matter, and that probably if you are not in some way concerned with the ultimate installation, should one be carried out, you will suffer material damage both pecuniarily and professionally. I wish, therefore, to propose to you that you should come and have an interview with me here at my office, so that we might, if possible, arrive at some arrangement by which we could both take an active part in the consummation of that which we must both desire, namely, the erection at Folkestone of electric lighting works.

I am, yours truly,

F. H. Medhurst.

P.S.—If Saturday would be a convenient day for you, I could see you here at 12 noon on that day.—F. H. M.

Mark Parker, Esq., consulting engineer,
Strood, Rochester.

November 15th, 1894.

Folkestone Electric Lighting.

Dear Sir,—I am greatly surprised by the receipt of your letter, dated the 13th inst., inasmuch as you have failed to pursue the only course open to a man honourably disposed, but who may unwittingly have injured another. Until you have adopted the course indicated, I must decline to hold communication with you.

I am, yours faithfully,

Mark Parker.

Francis H. Medhurst, Esq.,
13, Victoria Street, S.W.

Recording Instruments.

Referring to your leader of December 7th, you may be interested to know that a recording voltmeter, which is almost identical with the one sketched out by you, has been in use at Kensington Court for some months, and has been so successful, that we have decided to work out a complete series of recording voltmeters, ammeters, and large open scale indicating instruments. The above-mentioned voltmeter was designed by Mr. W. H. Miller and myself, and is of the D'Arsonval type; it is exceedingly sensitive, free from hysteresis errors, dead beat, and the force acting to turn the coil is sufficient to render the very slight friction at the pivots negligible. When properly made the scale is proportional, and can be varied to suit any requirement. The drum can be driven at any speed by means of suitable gearing, which is thrown into or out of action by moving a small lever. Either an ordinary clock movement may be used, or a special constant speed electromotor, as may be preferred.

We have endeavoured to reduce the cost by careful consideration of every detail of design and manufacture, rather than by sacrificing either good workmanship or finish.

W. Turvey.

Electrical Traction.

I observe that in a notice (Electrical Review, November 30th), on the paper I recently read before the Institution of Electrical Engineers, on "Electrical Steep Grade Traction in Europe," you complain of my having simply stated the total efficiencies of the different lines, without giving particulars. I expressly stated at the meeting that the limits of space and time would not allow me to enter into those details, and that as regards the three electrical cable railways, a full account by myself, with particulars of the efficiencies, would shortly be forthcoming in *Engineering*. As regards the other steep grade (adhesion and rack) lines to which I referred, the efficiencies on the Florence, Murren, Marseilles, and Salève lines were carefully worked out in my paper published in the *Proc.* Inst. Elec. Eng., and in *Engineering*.

C. S. Du Riche Preller.

December 12th, 1894.

Information Wanted.

I am at present interested in the question of electric motive power as applied to mill and factory work.

I understand that the Small Arms Factory at Liege is worked throughout by a series of small motors.

As I am expecting to be on the continent soon, I shall be glad if any of your subscribers could give me any information of other places worked on this plan, and if admittance can be readily obtained.

A Subscriber.

December 12th, 1894.

THE ELECTRIC LIGHTING OF CARDIFF.

The introduction of the electric light into Cardiff by the Corporation has created more hostility among the townsfolk than municipal enterprise usually encounters. Opposition up to a certain point is healthy and useful enough, but it so easily develops into obstruction. It is not necessary to analyse the nature of the antagonism to electric lighting at Cardiff. It was not altogether based on a desire to protect the ratepayers, nor was it quite free from personal feeling. Still it invested the introduction of the electric lighting with an interest which might otherwise have been wanting, for Cardiffians cannot be accused of over enthusiasm.

There are some points about the system of supply which are interesting. It is, briefly, a high-pressure alternating one, with motor commutators.

A high-pressure system was adopted, owing to the scattered nature of the town, Cardiff being divided into four large districts, Canton, Roath, Granton Town, and the Docks, which are some considerable distance from the compulsory area. Even if it had been possible to build the station within, or near, the compulsory area, it would have been just as far from the residential district as it is now; and a high-pressure system would still have been necessary to supply the outlying neighbourhoods. One system being imperative—and that a high-pressure one—the Corporation, owing to the difficulty of obtaining land at a fair price, were driven to build their works at Canton about a mile outside the compulsory area.

The Corporation having made up their minds to light the main thoroughfares by arc lamps, it was decided as early as October, 1891, when the deputation of the lighting committee had visited Frankfort to use some sort of rectifying apparatus for the arc lights.

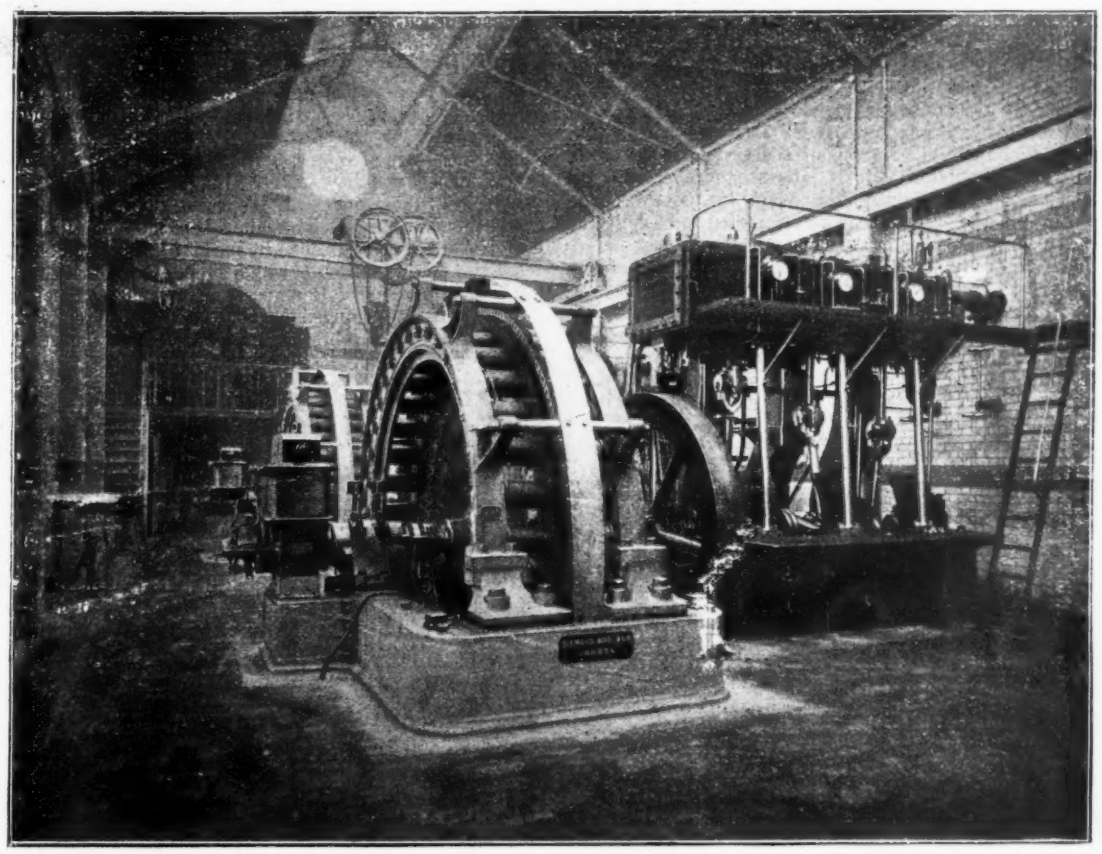
The Works.

As we have already stated, the works are at Canton, on the outskirts of Cardiff. The buildings have the appearance of being solidly built. Owing to the nature of the ground the station will be eventually a long and narrow one; at the present moment it is about 80 feet square. Any future extensions will be obtained by lengthening the present building, the ground being sufficient to allow of an addition in length of 240 feet.

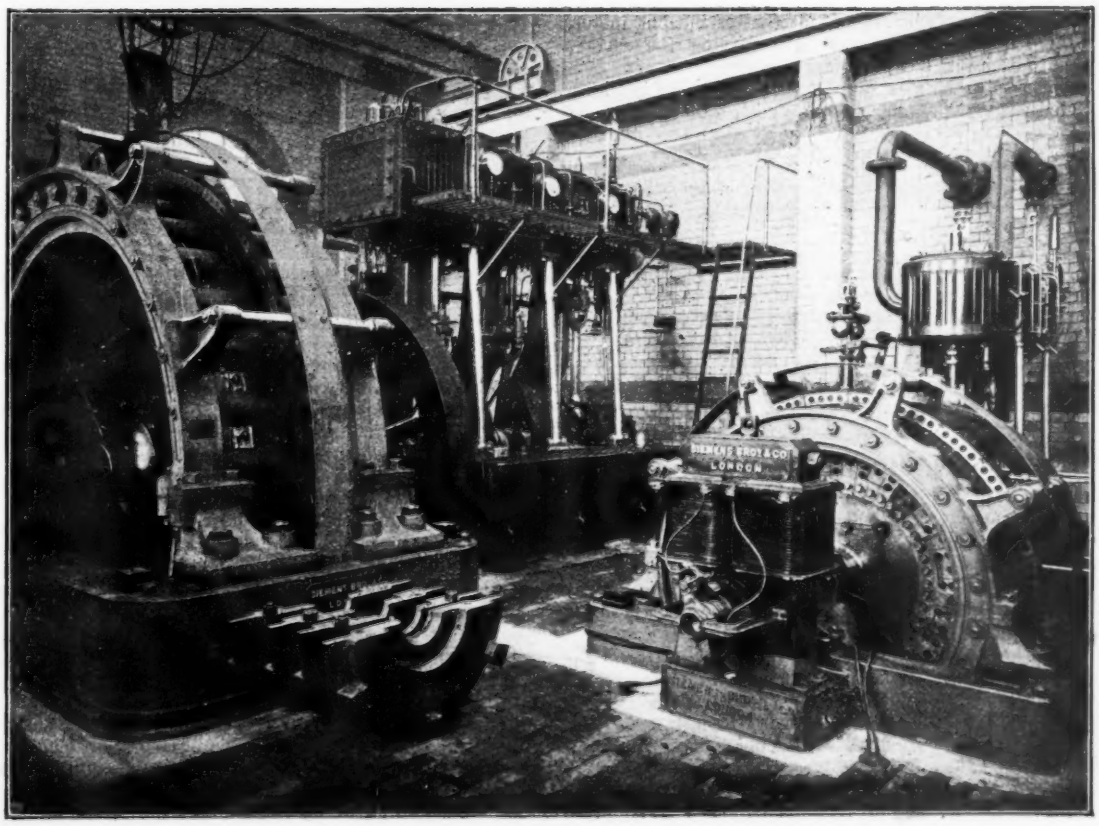
At the present moment there are four direct coupled sets of alternators and engines. The alternators are by Siemens, and have armatures of the disc type; there are two large sets and two smaller ones. The alternators are in each case coupled to engines, by Davey, Paxman & Co. The two large alternators have each an output of 180 kilowatts, the smaller ones giving each 40 kilowatts. The alternators are probably the largest of this type ever used in this country. As will be seen from the illustrations, the exciters are in each case built on the alternator shaft.

The two large engines are triple expansion, each of 270 B.H.P.; they are of the Windsor type, inverted cylinders and fly-wheel attached, run at 130 revolutions per minute, and are condensing. The small ones, which are compound, develop 65 B.H.P. each.

The station seems to be above all things remarkable for its solidity and simplicity. The arrangement of the plant is excellent, and there is a marked absence of ugly steam pipes, which is usually one of the most objectionable features of English central stations. We are perhaps speaking from an æsthetic rather than from an utilitarian standpoint, but there is not the regard for proportion in many of our electricity works which we should like to see. We do not



A General View of Station.



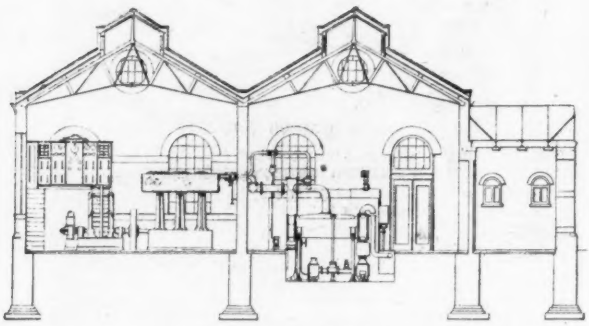
View of Large and Small Machines.

counsel the sacrifice of utility for artistic effect, but a well-designed station is just as efficient and as useful as a badly-designed one. The simplicity of arrangements extends to the switching apparatus, which recalls some of the essentially practical German stations.

The boilers are of the "Economic" type, and are made by Davey, Paxman, & Co.

The most important point about the system is the use of the motor commutators. It is interesting to record, as a mere matter of history, that the tender for these was submitted in June, 1893, and they were expected to be delivered by the end of September in the same year.

We have already mentioned that the visit of the lighting committee to Frankfort impressed them with the advantages of rectifiers. For the introduction of rectifiers into Cardiff, a good deal is due to the present mayor, Alderman Carey, J.P., who was deputy chairman of the lighting committee, and in the frequent absences of Councillor W. E.

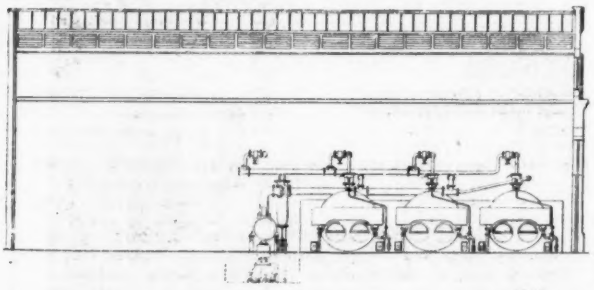


End Elevation of Station.

Vaughan through illness, acted as chairman. After the return from Frankfort the committee determined to adopt some system of rectifiers, and interviews with Mr. Ferranti took place. In the end Messrs. Ferranti, Limited, were called upon as sub-contractors to supply motor commutators.

At the present moment there are two double-ended motor commutators, on the Ferranti patent, each consisting of a self-starting single-phase synchronous alternating current motor, with the requisite commutator for rectifying the current required to excite its own field magnets.

The armature shaft is supported in four long bearings, lubricated with ring automatic oiling gear, fitted at each end



End Elevation of Boilers.

with a commutator, each of which rectifies the current from an arc light transformer. The commutator brushes are held in a concentric frame which can be rotated to adjust to the best point of commutation. Each motor is complete with a double-pole reversing and cut-off switch for changing over and breaking the connections to the arc light transformers.

In connection with these are two Ferranti patent high-tension transformers, which are arranged for transforming from 2,000 to 100 volts for feeding the armature of the motor commutator. These are enclosed in heavy cast-iron watertight cases, and are fitted with double-pole high-tension and low tension fuses.

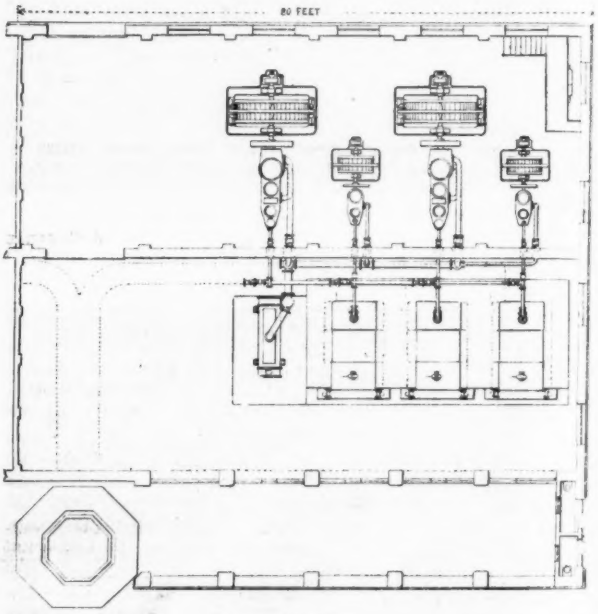
There are also four Ferranti improved constant current arc light converters, each of 10 units capacity, and complete with all the latest improvements, constructed for running continuously without undue heating, and arranged for giving a constant current of 12 ampères.

As showing the great adaptability of the motor commutators, it is only necessary to mention that they are placed almost at the extreme end of the system. At the present moment they are placed in a temporary chamber under the Town Hall, the negotiations for the purchase of a piece of land not being complete. The advantages of such an arrangement are that smaller circuits can be used for arc lighting without materially increasing the number of mains, and the E.M.F. of each circuit is kept more constant.

The arc lighting is done by means of four circuits. There are two rectifiers, each of which supplies two of these circuits. Twelve arc lamps of 12 ampères are arranged on each circuit. The lamps are arranged alternately on the circuits, so that with two circuits working out of the four, the streets are fairly well lighted.

The Incandescent Lighting.

The incandescent lighting is wholly done from street transformers. There are at the moment six transforming points. The transformer chambers are merely cast-iron boxes 3 feet by 4 feet, sunk into the ground; the transforming apparatus is by Siemens Bros., and converts from 2,500 volts to 105 volts, and are of 40 kw. The distribution is done entirely on the two-wire system, which is not, however arranged in a ring main, though there are means of doing i by intermediate junction boxes. Both high and low tension cables are laid in 3-inch cast-iron socket pipes with turned



Plan of Station.

ends, and are all jointed with lead; the street boxes are of iron; throughout the entire system every piece of metal is metallically connected, a precaution amply justified by recent experience. It is interesting to record that the excavating and the laying of the pipes for the mains have been done by the Corporation employés under the supervision and control of Mr. Harpur, the borough engineer, who, by the way, architected the station. In the laying of the pipes Mr. Harpur was assisted by Mr. R. H. Fletcher.

Both high and low pressure mains have been supplied by the India-rubber Company. The high tension mains are of the concentric type, with special thick insulation; the conductors are respectively equal to 7/16, 19/16, and 19/14. They are insulated first with pure and then with vulcanised India-rubber, afterwards sheathed with return conductor of tinned copper wires, a further insulation of pure and vulcanised India-rubber, and then the whole is vulcanised together, braiding and taping completing the cable.

For the low tension cables, Silvertown class "Y" is used, which are non-concentric cables laid in pairs.

While there can be little doubt that the incandescent lighting will be soon popular with consumers, and profitable

to the Corporation, it cannot be said to have boomed. As a matter of lamentable fact, when the station was ready to supply current, there had been only three applications for current. Yet the public mind of Cardiff is so peculiarly constituted, that it is anticipated the demand next year will exceed the supply. The output at the moment is about 26 kilowatts, a by no means extensive supply, but full of promise.

In minor matters Cardiff has departed from the traditions of electric supply; it is absolutely innocent of meters, and it has had the temerity not to issue regulations for the wiring of houses. Still the corporation is not likely to suffer over much from the want of meters, for it is proposed to charge 15s. per annum for an 8 C.P. lamp and 22s. for a 16 C.P., and so on. We all know that meters do not lead blameless lives, but whether the arrangement adumbrated above is the best way of charging, remains to be seen. It is obvious that such a method saves a good deal of trouble, and if the consumers do not object to the system, nobody else can grumble.

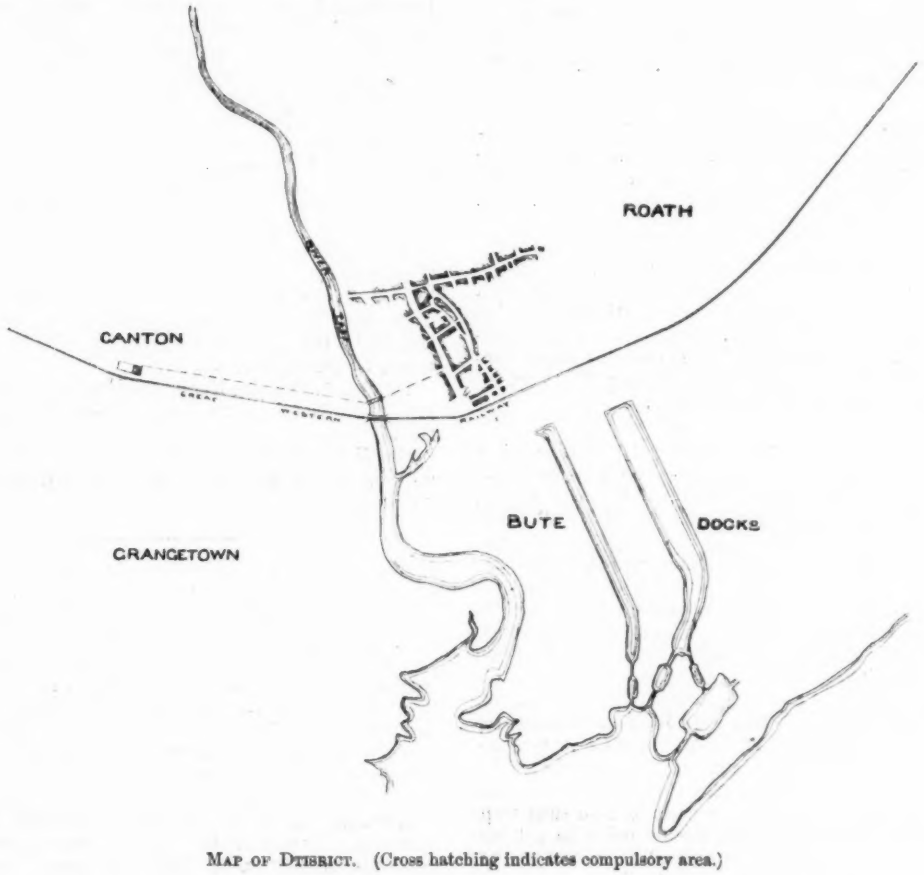
The decision of the Corporation not to issue the usual regulations for wiring houses raises one or two curious points. The position of the Corporation as suppliers of electric energy is this: they refuse to turn on current to any building until the insurance company with which such building is insured issue a certificate to the effect that the wiring has been carried out to their satisfaction. This has the effect of throwing the entire responsibility on the insurance company. In most cases insurance companies have taken the word of the wiring contractor that the work has been carried out in a satisfactory manner. Usually the contractor would reply to a formal set of questions and the insurance office would accept them without making an inspection. It is quite likely, however, that in the event of a fire, the formal questions answered by the wiring contractor might enable the insurance company to evade the claim set up against them. There are many instances where an inspection by a fire office would be difficult, and, generally speaking, insurance companies are not too well equipped with the means of making reliable tests. Still, an action sustained on the lines of that laid down by the Cardiff Corporation would need some serious consideration by fire offices as a body.

Conclusion.

From the arrangement of the plant we should expect that the day load ought to be coped with economically, and with the ultimate output we may expect fairly economical working.

Messrs. Massey and Allpress are the consulting engineers, and are to be congratulated on the substantial results of their labours.

The cost of the works up to the present is, we understand, under £30,000.



Map of District. (Cross hatching indicates compulsory area.)

NOTES.

Another Medical Man Erased from the Register.—From a Scotch daily we learn that the General Medical Council has decided to erase the name of Mr. Robert Masters Theobald from the register, in consequence of unprofessional conduct in publishing and circulating a book named "Electro-homœpathic Medicine," in which was contained a description and recommendation of the so-called electro-homœpathic cures and medicines of one Count Mattei, and in which it was suggested to persons suffering from disease to adopt these so-called cures and medicines.

The Northern Society of Electrical Engineers.—The following is a list of officers and council for 1895, as elected at the annual general meeting held on Monday last, December 10th:—President, Mr. Henry Edmunds; Past-president, Dr. John Hopkinson, F.R.S.; Vice-presidents, Mr. G. E. Preece and Mr. W. P. James Fawcus; Hon. Solicitor, Mr. John B. Parkinson; Hon. Treasurer, Mr. George J. Somerville; Hon. Secretary, Mr. John Darney. Members of the council:—M. A. B. Blackburn, Mr. Thomas Browett, M. E. A. Claremont, Mr. S. V. Clirehugh, Mr. G. S. Corlett, Mr. E. W. Cowan, Mr. C. M. Dorman, Mr. G. W. Lowcock, Mr. E. Manville, Mr. J. H. Rider, Mr. James Taylor, and Mr. C. H. Wordingham.

The City Company's Staff. — We understand that Mr. David Cook, the engineer to the City Company, and Mr. Alexander Cook, the superintendent of mains, have resigned their positions.

The Western and Brazilian Telegraph Company, Limited.—This company yesterday received a telegram from their Rio de Janeiro representative stating that the "Bill passed second reading in Upper House Tuesday."

Personal.—The business friends of Mr. L. C. H. Mensing will regret to hear that one day towards the end of last week that gentleman was knocked down by a horse and cab in the neighbourhood of Charing Cross. He was conveyed to the hospital, and from thence to his home. We understand that though no bones were broken, Mr. Mensing received a very severe shaking, which will prevent his personally attending to business for a week or 10 days.

Circulation v. Non-Circulation Fuel Economisers.—We have received a letter from Mr. James G. Calvert, of the Calvert Circulation Economiser Company, relative to the note on page 664 of our issue of November 30th. Mr. Calvert wishes us to state that the circulation economiser used for the trials in question was *not made* by his company, that the company knew nothing of the tests, and that a proper public trial of his apparatus in competition with others has already been arranged for at the City of London Electric Light Company's station. We regret that we cannot publish Mr. Calvert's letter; but it contains expressions which we feel justified in withholding from publication, for our own sakes as well as for Mr. Calvert's.

The Pacific Cable.—The following is a copy of a despatch appearing in the *Montreal Gazette* (the Montreal organ of the Canadian Government) :—"Ottawa, Canada, November 19th, 1894 : Referring to Sir John Pender's public statement that the Atlantic cables do not earn adequate returns, and that this ought to be a warning to Governments in the case of the Pacific cable, those who know the facts are in no way surprised that some of the Atlantic companies do not pay good dividends, considering the extent to which their stock is watered. Sir John will not be able to get the Commercial Company's statement that Atlantic cables are not a profitable investment, as this company has kept out of the ring with which he is associated. Sir John characterises the Pacific cable as a foolish project, but he has, of late, repeatedly evinced great anxiety in carrying it out. The warning which he gives may, however, have its use in a way he does not intend, in determining the Governments to take such steps as will render it impossible for the Pacific cable to get into the category of water-logged companies, like so many other companies with which Sir John is familiar."

Electricity in Mines.—Mr. A. L. Steavenson has written as follows to *Engineering* :—"On the occasion of the meeting of the British Association in Newcastle, during the discussion upon transmission of power, I pointed out that in a dark mine there were special dangers; a man making a false step might put out his hand and touch a wire, resulting in injury or death. The reports published were not good, and much discussion arose as to what Mr. W. H. Preece, who poohpoohed my remarks, had really said, so on September 24th, 1889, he wrote to the *Times* : 'What I did characterise as absolute nonsense, was the reason a mining engineer adduced against using electric currents in mines, viz., that a man who touched such a wire would be killed; such currents are invariably direct currents of low pressure, and are, therefore, quite safe.' Now, in the Electrical Review of yesterday I read : 'On Thursday last week James M'Multy was killed instantaneously by coming in contact with the electric haulage apparatus in Bogside pit, belonging to the Lanemark Coal Company. While in the act of lifting the switch, the side of his head touched a defective casing in which the electric wire runs, and stuck fast. Another miner caught hold of him, but was thrown off by the shock. Presently the driving engine was stopped, and the body of the man fell lifeless.' It would be interesting to know something of the force of the current, which I am trying to get; meanwhile it may be seen that I was not talking 'absolute nonsense.'"

Failure of the Electric Light in Oxford Street.—On Tuesday afternoon, about 5 o'clock, there was a failure in the supply of the Metropolitan Electric Supply Company, plunging the whole of the shops in Oxford Street which are supplied from their mains in darkness for about 15 minutes.

Lectures.—Prof. Silvanus Thompson entertained a crowded audience at the London Institution on Monday night with a lucid and interesting discourse on "The Working of Electric Motors."

Mr. Wm. Kingsland, A.I.E.E., delivered a public lecture at Llandudno on November 30th, under the auspices of the Llandudno Literary and Scientific Society, on "Magnetic Mysteries." Commencing with the familiar phenomena of magnetism and electro-magnetic induction, the lecturer gradually led his audience to the threshold of those problems of electro-magnetic waves, and their relation to the ether and to light, with which we are now face to face. The lecture was illustrated at every point by numerous and striking experiments and limelight diagrams.

Under the auspices of the Newport Literary Society, Mr. Robert Hammond, last week, delivered a lecture on "The Electric Light: its Utility and Cost."

A lecture was delivered last Friday night in the large Chemistry Lecture Room at the Glasgow Technical College, by Mr. Henry A. Mavor, M.I.E.E., the subject being "A Talk about Electrical Engineering. Prof. Geo. G. Henderson, M.A., D.Sc., occupied the chair. The lecture was illustrated by limelight views.

Mr. W. A. Douglas-Rudge delivered a lecture at the Plymouth Institution on 29th ult. on "Electric Light Installation."

On Wednesday last week Prof. Barrett, F.R.S.E., delivered a lecture in the Molesworth Hall, Dublin, his subject being "Faraday and Some of His Discoveries."

Society of Civil Engineers (France).—On the 16th ult. a long paper by M. Dumont, relating to the transmission of energy by electricity, was read before the French Society of Civil Engineers. This paper does not furnish any new data, but it sums up pretty accurately the state of affairs. It is to be regretted, however, that M. Dumont has not thought fit to discuss more fully certain points which are worthy of attention. The writer showed first, that before the time of electrical transmission by dynamos the methods employed were imperfect and very limited, such as teledynamic cables. It is, moreover, an established fact that it was not possible to transmit more than 300 H.P. by these methods. Then came the electrical methods, and these gave more favourable results. But it was necessary to use rather high tensions. M. Marcel Deprez tried to construct high tension continuous current dynamos, but was not able to exceed 3,000 volts. With these tensions an industrial efficiency of 60 to 75 per cent. has been attained, at a cost for installation of 652 to 320 francs per horse-power. Then alternators came into use, which enabled much higher tensions to be used; but then it was necessary to have recourse to one transformation at least, and sometimes to two successive transformations at starting and arrival. In experiments on the transport of energy, industrial efficiencies of 58 and 61 per cent. have been attained. M. Dumont quotes especially the example of Tivoli, Rome, when 1,900 H.P. were transported at a tension of 5,100 volts, with an industrial efficiency of 50 per cent. of the motive force. The alternating current motors presented great difficulties as regards starting; but all these defects have been studied and solved by the employment of revolving fields, or by the employment of di-phased and tri-phased currents. M. Dumont mentions the Lauffen experiments in 1891, and the transmission effected in 1894 at Messrs. Menier's establishment at Noisiel. He then arrives at the electrical transmission of energy into workshops, and quotes the experiments performed at Berlin by M. Hartmann and by the Siemens & Halske Company. He then discusses modes of transmission in a workshop where the various machines are driven by groups of engines, or by single engines. Finally, he concluded by exhibiting drawings of various installations of electrical machines, lifts, cranes, roller bridges, &c.

NEW COMPANY REGISTERED.

National Electric Engineering Company, Limited (42,605).—This company was registered on the 29th ult. with a capital of £5,000, in £1 shares, to adopt a certain agreement made between A. C. Cockburn and others for the acquisition of the business of electrical engineers now carried on by A. C. Cockburn and D. C. Bate, at 2, Holborn Place, W.C., and now or late at 1, Gresham Street, E.C., and 73, Bridge Street, Manchester. The subscribers are:—A. C. Cockburn, 22, Smatley Road, N., engineer, 100 shares; D. C. Bate, 127, East Dulwich Grove, S.E., electrical engineer, 100 shares; J. W. Smith, Regent's Park, N.W., gentleman, 1 share; H. T. Wallace, Wandsworth Common, musician, 1 share; M. A. H. Cockburn, Brondesbury, married woman, 1 share; M. E. Bate, 127, East Dulwich Grove, S.E., married woman, 1 share; J. C. Bowler, 118, New North Road, N., book-keeper, 1 share. The first directors are A. C. Cockburn and D. C. Bate; qualification, 500 shares; remuneration to be fixed in general meeting. Registered by F. Walker, 157, Winchester House, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electric Fittings Hiring and Maintenance Company, Limited (35,551).—This company's last return shows that only seven shares have been taken up out of a nominal capital of £200,500. Nothing has been called or paid.

Reading Electric Supply Company, Limited (35,651).—This company's latest return shows that only seven shares have been taken up out of a nominal capital of £75,000, in 15,000 £5 shares. Nothing has been called or paid.

Dawson Gas Engine Syndicate, Limited (41,844).—This company's statutory return has been filed, and shows that out of a nominal capital of £70,000, in £10 shares, 6,696 shares have been taken up, and that 5,600 of these have been issued as fully paid (£56,000). On each of seven shares the full amount has been called, and £6 per share has been called on 1,089 shares. The total sum received equals £5,786. There is £818 outstanding.

Electro-Magnetic Medical Plaster Company, Limited (39,111).—This company's last return, filed November 13th, 1894, shows that out of a nominal capital of £10,000, in £1 shares, 3,290 shares have been taken up, and that 2,000 have been issued as fully paid. A sum of 10s. has been called on the remaining 1,290 shares; £620 has been received, and £25 is in arrear.

BUSINESS NOTICES, &c.

Universal Electrical Directory (J. A. Berly's).—Messrs. H. Alabaster, Gatehouse & Co. have now in course of preparation, and rapidly approaching completion, the 1895 edition of this directory. Names and addresses for insertion, corrections, and orders for advertisements should therefore be at once forwarded.

Aberdare.—A meeting of those interested in the electric lighting of Aberdare was held on the 30th ult.; several of the leading tradesmen, and others, of the town were present. They met to consider the advisability of providing a scheme to light the town by electricity. After considerable discussion a committee was appointed, consisting of the gentlemen who recently visited Pontypool to co-operate with the agent for Messrs. J. C. Howells, Llanelly, in canvassing the tradespeople. It is proposed, at present, to go in for the low-tension system, and to light up the business part of the town, including Commercial Place, Commercial Street, Cardiff Street, and Cannon Street, although Parliamentary powers have been obtained to supply electricity within half-a-mile radius of St. Elvan's church.

Bedford.—Mr. F. H. Medhurst informs us that the Bedford Corporation Electricity Supply Works were officially opened by the mayoress on the 6th inst., since which time they have been in constant operation day and night, supplying the current for lighting and other purposes.

Bolton.—The electrical engineer has been instructed to arrange for the requisite mains to be laid for the supply of electricity to premises in Acresfield and Mawdsley Street. Alderman Miles and Councillor W. Cooper were requested along with the engineer to consider and report upon the alterations which it was desirable to make to the electric lamp on the Town Hall Square.

Brechin.—The large electric lamp at St. Ninian Square, to light which Mr. Robert Dick made an offer to the town to supply electricity equivalent to 1,000 candle-power free, has just been erected.

Canterbury.—Consideration of the electric lighting question has been deferred by the Town Council for six months.

Cheltenham.—The librarian is desirous that the public library should be lighted by electricity. Inquiries are being made as to the probable cost.

Chester.—A Local Government Board inquiry was held here on the 6th inst., into an application by the town council to borrow £25,000, for the purpose of electrically lighting the city. There was practically no opposition. The council have not yet decided on the system of lighting.

Chiswick.—We understand that the Local Board have approved of the plan for a new electric light station submitted by Messrs. Bourne & Grant.

Devonport.—On the occasion of the visit of Lord Rosebery to Devonport last Tuesday, the South Western Railway Station, where the premier spoke, was lighted by electricity by Messrs. Veale, of St. Austell.

Dewsbury.—The corporation electricity supply station was officially opened on Monday last by the Mayor.

Dover.—The Town Council resumed the discussion on incandescent gas *versus* electric lighting at last week's meeting. The result of the discussion was that the Gas Company's contract for lighting Cannon and Biggin Streets was renewed for another twelve months, subject to proper stipulations as to the mantles. The Electric Lighting Company, are, however, to submit their tender. The council has given the Electric Lighting Company permission to extend their mains along Beach Street, and also up to the Buckland Church.

Dundee.—At a meeting of the Gas Committee of Dundee Town Council last week, the question of the extension of the electric lighting to the Technical Institute was under consideration. It appeared that the capital to be expended would amount to upwards of £500, and that the Technical Institute committee hesitated to pay that amount. The committee, after consideration, were of opinion that they could not incur so great an expenditure outside their district, and the clerk was instructed to communicate accordingly.

Edinburgh.—The Town Council the other day remitted to the Lord Provost's committee to consider and report as to whether it is desirable at this stage to arrange for laying down electric light high-tension cables from the station to Nicolson Street for the purpose of supplying domestic lighting through transformers.

Egypt.—A Belgian syndicate is reported to have secured a concession from the Egyptian Government for the establishment of a system of electric tramways at Cairo.

Fareham.—At the Local Government Board inquiry last Friday, re raising a loan of £7,000 for the purchase of the electric light works, &c., it was stated that a "vast majority" of the ratepayers were against the purchase.

France.—An electric tramway is to be laid down in the park at Bordeaux in connection with the exhibition which is to be held in that town next year.

Glasgow.—At a meeting of the Sub-Committee on Finance held on 28th November, the treasurer reported the collection of gas rents at this date as follows:—1894-95, £31,860 17s. 2d.; 1893-94, £28,217 9s. 8d.—increase, £3,643 7s. 6d. The treasurer also reported the collection of electric lighting rents at this date as follows:—1894-95, £3,185 13s. 10d.; 1893-94, £2,118 0s. 7d.—increase, £1,067 13s. 3d.

Halifax.—Last Friday night the electric lighting installation which has been laid down in the Trinity Road Baptist Chapel, Halifax, was tested for the first time.

Mr. Ross Cotton (of London) has been appointed assistant electrical engineer to the Local Board.

Hanley.—At a recent meeting of the council it was reported that correspondence had passed between the Brush Electrical Engineering Company and the Committee, as to the plant and apparatus supplied at the Hanley Works, and the company had stated that they would send one of their engineers to supervise and be responsible for the running of the plant for a month, in order to demonstrate that the plant was in good working order.

Hastings.—The Hastings and St. Leonard's Electric Light Company recently served the Council's committee with notice that they intended constructing a transformer chamber under the

public pavement at London Road, St. Leonard's. The Council has consented to the application conditionally. The company further wanted to lay a main and main boxes down a certain portion of Queen's Road, but the Council have withheld sanction for the present, as the plans do not clearly show where and how the works are to be executed.

Hull.—At a recent meeting of the Electric Lighting Committee, the chairman remarked that on Wednesday the private plant supplying the electric light to the Imperial Hotel broke down. The manager required 158 lights, and as the supply gave out in the morning, and Mr. Feller found he would be without any light at night, he applied to Mr. Gibbings, the committee's engineer, who in four hours had temporarily attached the Imperial Hotel to the corporation mains, and in the evening the hotel was lit as usual. He thought this was very satisfactory, especially as he had now an application from Mr. Feller for a constant supply of electric light from the corporation.

Isle of Man.—The St. George's Woollen Mill, Laxey Glen, has been fitted up with an installation of the electric light by Mr. Tennant.

Kilwinning.—At the Lady Sophia Pit, belonging to Messrs. William Baird & Co., electric lighting has been introduced. In the underground passage nine 16-C.P. lamps have been fitted, and on the surface there are 24 of greater intensity.

London.—The London Hospital governors have resolved that in the event of the Whitechapel Board of Guardians establishing a public electric lighting installation, they would be prepared to consider favourably the question of lighting the hospital by electricity.

Manchester.—It seems that the Manchester Public Hall Company have been extravagant in their use of the electric light since they adopted it in place of gas. Their gas lighting formerly cost about £400 per annum, and now gas and electricity together amount to £800 per annum. With the guidance of the engineer to the Corporation, it has been found possible to cut off many lights in the smaller room, and in this way the cost will be reduced by £150 to £200 per annum. If it is possible to effect such a large reduction in the bill and yet have the various parts of the premises lighted satisfactorily, it would seem that when having the fittings put in the Hall Company did not study economy.

Milford Haven.—St. Catherine's Church, Milford Haven, is lighted by electricity.

Newcastle.—According to a provincial daily, the opponents of the cable tramways in the Newcastle Corporation tried the other day to cancel the Parliamentary notice given in an application agreed to by the majority of the Council for a provisional order and borrowing powers. They hold out for some future betterment through electricity. Two divisions were taken, and the order was only carried by a majority of one.

The Town Council has appointed a special committee to consider the desirability of their undertaking the supply of electricity.

Oldham.—After making inquiries, the Electric Lighting Committee report that they do not consider the demand justifies an extension of the mains.

Portsmouth.—The Town Council has decided to appeal against the assessments made of the electric lighting station and mains, these being assessed at £500 in the parish of Portsmouth, and £3,000 in the parish of Portsea, which the Council consider excessive.

Prescot.—A great deal of interest has been aroused at Prescot, says the *Liverpool Mercury*, by the announcement that Mr. Hazlehurst, the Government auditor for the district, had surcharged Messrs. Edward Dyson, James Berry, and Joseph Preston, members of the Local Board, to the amount of £362 17s. 3d. in respect to payments to the British Insulated Wire Company for the lighting of the town by electricity. The auditor, in his report, stated that the company had failed to carry out their agreement with the local board in regard to the extent of the district and the number of lamps to be lighted by electricity, and that the members of the Local Board, with the full knowledge of the facts before them, had improperly and illegally made payments of £187 17s. 3d., £87 10s., and £87 10s. to the company. The auditor also pointed out that the agreement with the company was invalid for the want of a penalty clause. At the audit of the accounts the surcharged members maintained that the ratepayers had received more in the way of lighting than they had contracted for, and that certain "extras," which had cost the company £119 11s. per annum, had been given to the town without any extra payment from the board. Mr. Haslehurst admitted that the surcharged members had excellent grounds for asking the Local Government Board to remit the surcharges, but he (the auditor) was confined to the statutes and was bound to make the surcharges indicated. He suggested that a new agreement with the company should be entered into, and it was explained that the Local Board now had the matter under consideration.

Proposed Electric Tramway at Pontefract.—In consequence of the poor means of communication between Pontefract and Featherstone, and the Lancashire and Yorkshire Railway Company having no late train, Councillor McGowan the other night, at the Corporation's meeting, moved that the question of providing an electric tramway between Pontefract and Featherstone be referred to the Markets and Highways Committees. He had made inquiries, and the scheme was quite feasible. The whole question of communication was referred to the committees.

Rathmines (Ireland).—A committee has been appointed to consider the advisability of introducing the electric light into the township.

Richmond.—The estimates of Messrs. Harrison Coles & Co. have again been accepted by the corporation of Kingston to erect electric calls to all the members of the fire brigade, stables, and police station, telephones to turncocks, &c., and street fire alarms in various parts of the borough. The same firm has just completed the fire calls at Kew.

Rimington.—Newby Mill has lately been lighted by electricity. Forty-five 16-C.P. lamps are at present in use.

Salford.—According to the Chairman of the Gas Committee, borough householders need not expect the electric light this winter "as the contractors appear to be hopelessly behind." The charge per unit is to be 7d.

Sheffield.—The new Hospital in West Street is to be lighted by electricity. Many other important consumers have been connected to the supply mains of the Sheffield Electric Light and Power Company during the past few weeks, and the resources of the company to supply the demand are greatly strained. We understand it is expected that the company's new machinery for supplying an additional 10,000 lights will be running by the end of this year.

Stafford.—The County Council have decided to light the Technical Instruction Buildings by electricity.

Stanley.—A correspondent of the Dundee *Advertiser* recommends the lighting of the village by electricity, adjacent water power being brought into use. The present intention is to light the streets by paraffin.

Speldhurst.—Messrs. Drake & Gorham have obtained the contract for the electric lighting of Mr. E. Janson's house at Speldhurst by means of a separate plant with accumulators of the D.P. type. The house is being lighted throughout.

Sunderland.—One-sixth of the producing capacity of the works has been applied for. The engineer expects the supply will commence in the middle of January, and states it would be necessary to appoint an assistant electrical engineer.

West Hartlepool.—The Electric Lighting Committee last week had the electric lighting question under consideration. Information was put forward regarding the success, or otherwise, of installations in other towns, but no decision was arrived at though the general feeling of the councillors was in favour of the proposal.

Weston-super-Mare.—The Town Commissioners on Wednesday last week received Mr. Medhurst's report on electric lighting, electric tramways, and refuse destructors. The report was an exhaustive one, and the committee have reported most favourably upon it.

Worcester.—An arc lamp is to be fixed at each side of the Guildhall gates at a cost of £47 10s.

Wishaw, N.B.—The Commissioners have retained the services of Mr. Mavor, Glasgow, as electrical engineer for the proposed electric lighting of the town.

York.—The Municipal Offices Committee have submitted to the City Council a statement of the expenditure to September 30th, 1894, and estimate of further expenditure required upon the municipal buildings, courts of justice, police and fire brigade stations. This includes the following items:—Electric wiring, £187 18s. 5d.; electric bells and speaking tubes, £124 9s. 9d. Estimated further expenditure—Heating apparatus, furniture, electric lighting, fittings, &c., £500. Expenditure upon courts of justice, police, and fire brigade stations, to September 30th, 1894:—Electric lighting, £1,493 11s. 6d.

African Trans-Continental Telegraph.—According to advices received at Cape Town from the Chinde River, the Portuguese persistently obstruct the permanent extension of the transcontinental telegraph across Portuguese territory in the direction of Tete. The work is consequently at a standstill.

Agency.—Mr. Archibald Campbell, of 28, Gray's Inn Road, W.C., has been appointed sole agent for the sale in London and the metropolitan area, of the manufactures of the Munro's Electrical Manufacturing Company, Limited.

Bankruptcy.—On Monday last a petition was presented for a receiving order against Mr. Loftus John Barnacle, trading alone as A. H. Hall & Co., at 1, South John Street, Liverpool, as an electrical engineer. The debtor appeared in person, and the petitioning creditors were a firm of electrical engineers in London. The Registrar granted a receiving order.

Book Received.—The Tutorial Physics, Vol. I. *Text Book of Sound*, by Edmund Catchpool, B.Sc., &c. Published by the University Correspondence College Press, 13, Booksellers Row, Strand, W.C. Price, 3s. 6d.

Electric Organ.—St. John's Church, Yeovil, has lately been fitted with a new organ which is controlled on the Hope-Jones electric system.

London Branch. — Weyman & Hitchcock, Limited, makers of the "Trusty" oil and gas engines, have opened an office at

11, Queen Victoria Street, E.C. This firm recently removed to large and well equipped works at Cheltenham, equal to an output of some 500 or more engines per annum.

New Branch.—Messrs. E. H. Cathcart & Co., electrical engineers, &c., of 4, Dorset Buildings, Salisbury Square, Fleet Street, E.C., have opened a branch office at 62, Vauxhall Bridge Road, S.W.

Personal.—We are informed that Mr. Garcke will retire from the position of managing director of the Electric Construction Company, Limited, upon the expiration of his agreement with the company at the end of the year.

Thomas Parker, Limited.—Some months ago we advised our readers that Mr. Thomas Parker and several of those who assisted him at the works of the company by which he was formerly engaged, had formed a limited company, known as Thomas Parker, Limited, and were about to erect new and extensive electrical manufacturing works in Wolverhampton. These works have now been completed, and were formally opened by the Mayoress of Wolverhampton (the Mayor, Lieut. Mander, being chairman of the company) on Monday, 10th inst. The site upon which the works have been built is in Wednesfield Road, opposite the Midland Railway Goods Department. There are erecting, fitting, pattern and machine shops, and a foundry for brass and ironwork. The building at the left of the entrance has been set apart for the erecting, fitting, and machine departments. It has four bays, two of them with a span each of 32 feet, and two with a span each of 42 feet 6 inches, and each of the four measures 150 feet in length, and in connection with each one also there are arrangements for travelling cranes. The iron columns carry the roof and rails for the travelling cranes. In the first bay there are the main engines for driving the whole of the works, and for testing the machinery before it is sent out. The steam for the engines is supplied by two large boilers made by Messrs. Babcock and Wilcox. In the second bay there are the larger tools, general erecting and testing machinery. The third bay is used as a machine shop, with lathes, milling machines, drilling machines, and general tools for carrying out work of any size. The fourth bay is for light brasswork, winding armatures, and other portions of machinery. The floor of this large building is of concrete with wood blocks. There is also a railway track, so that it can be connected with the Midland Railway Company's sidings. Four other large and valuable machines have yet to be laid down. The building is heated with steam from the main boilers with radiators. The travelling cranes and machinery are driven by motors supplied with electric current from one main dynamo, which will also supply the electric light for the building. The building which will be used for the foundry is 120 feet by 40 feet, and will be fitted with a 10-ton electric travelling crane. The pattern shop is 80 feet by 40 feet, the floor of which is of concrete, over which wood blocks are laid, and heated by steam radiators. Mr. A. P. Brevitt, of Wolverhampton, was the architect, and Mr. Henry Lovatt, the builder. Messrs. Heenan & Froude, of Manchester, have supplied the ironwork, and Messrs. McTear & Co., of Belfast, the roofs.

Works Lighting.—Messrs. William Balfour & Sons' engineering works at Ovenstone, have just been fitted up with the electric light.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—The municipal authorities of Oudenarde are just now inviting tenders for the lighting of the public streets of the town by gas, electricity, or petroleum, on and after the 8th April, 1896.

Birmingham.—January 12th. The committee of the municipal technical school are inviting tenders for the installation of generating plant, fittings, and appliances for both the electric lighting and transmission of power by electricity in the schools. Further particulars will be found in our advertisement pages.

Edmonton.—December 21st. The Local Board of Health invite tenders for the supply, delivery, and fixing of a system of electric call bells and telephones, for fire brigade and local board purposes. Full particulars may be obtained of Mr. G. Erds-Eachus, engineer to the board, Town Hall, Edmonton.

Germany.—Tenders have just been invited for the establishment of plant, &c., for the electric lighting of the harbour at Mainz.

Hanley (Staffs.)—January 5th. Tenders are invited for the supply and erection of the following plant for the corporation: Contract No. 10—Extension of engine-house plant, including 200-kilowatt alternator, 25-kilowatt alternator, and 20-kilowatt exciter, each separately driven by a compound steam engine, with all necessary steam and exhaust pipes, valves, switch-board and appurtenances. Contract No. 11.—Extension of condensing plant, consisting of circulating pump, air pump, boiler pump, surface condenser, with all necessary pipes and appurtenances. Details can be obtained at the offices of Mr. Joseph Lobley, borough engineer, Town Hall, Hanley.

Spain.—December 18th. The municipal authorities of the town of Valencia (Onteniente), are inviting tenders until the 18th inst. for the electric lighting of the public streets during a period of ten years.

CLOSED.

Cheltenham.—The following tenders were sent in for steam and exhaust pipes for the supply station:—

	W.I.	C.I.
Such & Larter	£73	£31
Thos. Piggott & Co.	£35	£60
Sharpe & Co.	no price.	£47
James Pollard	„	£47
Edwin Lewis & Sons ...	£125	no price.
Staveley Coal & Iron Co. ...	£10 10s. per ton.	...
"Silversters"	£38	£30 10s.

The tender of Messrs. Piggott for steam pipes and that of Messrs. Such & Larter for cast-iron pipes were accepted.

Hampstead.—We understand that last week the Joint Electric Lighting and Works and House Committee accepted the tender of Mr. F. H. Taylor, of 17, Ironmonger Lane, E.C., for carrying out the installation of the electric light at the Stone Yard. The amount of the contract is for £68 12s. 3d.

St. Pancras.—The following tenders were received for supplying and laying armoured cable mains, for the Vestry:—

W. T. Henley's Telegraph Works Company, Limited (accepted)	£17,104	16	3
Callender's Bitumen, Telegraph and Waterproof Company, Limited, ...	17,817	16	7
Do. (alternative tender)	17,760	6	7
Siemens Bros. & Co., Limited	18,581	7	9
Fowler-Waring Cables Company, Limited	18,645	13	4
British Insulated Wire Company, Limited	18,848	19	3
India-Rubber, Gutta-Percha & Telegraph Works Company, Limited	23,650	19	5
Do. (alternative tender)	21,713	13	8
W. T. Glover & Co.	25,767	7	8
Do. (alternative tender)	22,331	3	2
For extension of underground sub-station:—			
J. Steed (accepted)	208	16	9
J. O. Richardson	226	12	5
C. W. Killingback & Co.	244	7	5
J. Mowlem & Co.	284	0	10

Worcester.—The Council have accepted the tender of Messrs. Verity & Sons to substitute three electroliers for the three sunlights in the Assembly-room at the Guildhall, and to execute the necessary wiring at £49 12s. 9d.

CITY NOTES.

Woodhouse & Rawson.

A MEETING of debenture-holders of Woodhouse & Rawson United, Limited, was held on Tuesday at Winchester House, for the purpose of a statement being placed before them of the progress made in the realisation of the assets. Mr. F. D. Leslie (Robinson & Leslie), the receiver and manager, presided.

The CHAIRMAN said: I propose to give you a report which I have prepared, giving as clearly as possible the result of the liquidation of the assets that have up to the present been actually realised, and the estimated result of those assets which still have to be liquidated. In doing this I shall take the estimates of value based on the different groups of assets by the directors in their statement of affairs, and show you, when possible, by comparative figures, where and how the differences have arisen. I was, as probably most of you are aware, appointed receiver and manager for the debenture holders on March 10th, 1893, and on the same date I took possession of the books, documents, papers, and assets of the company. I need hardly say that it took me a considerable time to thoroughly acquaint myself with the nature of the assets, and, indeed, to find out where some of them were, also to obtain a full grasp of the situation. The books of the company—perhaps something like two hundred—were in anything but a complete condition, and, in fact, had not been posted since December, 1892. It was necessary that not only the books at the head office, but also the books at the various branches, should be written up before I could ascertain and trace the assets that ought to be at the various branches. Whilst this was being done, amongst many other things, two important matters required my immediate and constant consideration: First, the completion of the contracts entered into by the company and only partly carried through at the date of my appointment. Of course, on account of these contracts various sums of money had been received, and there were still considerable sums outstanding representing work already done under the contracts, and which, had the whole contract not been completed, would have been forfeited. I am glad to say that all these contracts have been completed, and no such forfeiture has occurred. Second, I had to consider which of the branches should be carried on, and also to ascertain which branches were of such a nature that to carry them on at all would only involve further and serious loss; having decided in which of these two categories the various branches must be placed, I had to take immediate steps to close down those in the second category, the carrying on of which would only have resulted in further loss. Much time was taken up in dealing with these matters, and in this connection I may say—although, perhaps, it is almost unnecessary—that in a large concern like this no serious steps could be taken without applying to the Registrar for authority to take such steps. This necessarily caused delay, as you know the court will not make any order without the fullest information being laid before it; but, at the

same time, it will, no doubt, be satisfactory to you to know that I have, in every case of any moment, taken such directions before acting. All the before-mentioned matters took up such an amount of time that at the end of the first six months of my trading as receiver and manager, I was not in a position to take out a trading and profit and loss account; in fact, I could not do so, as I had not received, and could not receive, from the foreign branches their returns. I, therefore, decided to take out a trading and profit and loss account at the end of my first year's trading, being as at March 9th, 1894. In taking out this account, and before I give you the result, I must say that the stocks on March 10th, 1893, were overvalued. Upon the trading at the head office and the branches (and, perhaps, at the moment I need not go into details, but may rather deal with the result as a whole), there appears a loss of £3,872 11s. 9d.; the greater part of which is accounted for by the fact that the turn-over was nothing like large enough to bear the standing charges, consisting of rates, taxes, rents, wages, salaries, &c., although in this connection I may say that immediately after my appointment, and during the whole of the time I have had the management of this business, I have given my attention to in every way cutting down the expenses. I reported to the court and received directions to take steps to close down the head office and branches, the result of which is that at the present moment I have closed down all the branches, with the exception of the head office, Manchester, Kidsgrove Works, Birmingham, Chiswick, South Africa, and Australia, and have ceased trading altogether. I will now proceed to deal with the assets. I am now negotiating for the sale of the assets at the head office, also for those at the Manchester, Kidsgrove, Birmingham, Chiswick, South Africa, and Australian branches. The Official Receiver, as you are aware, issued a statement of affairs under date of December 12th, 1893, setting forth therein the valuation of the various assets, as estimated and certified by the directors. I have found it practically impossible to give you a detailed comparative statement of the realisation of the general assets, as in many cases sales have been effected, including items appearing in the statement of affairs under several headings, the whole being sold at a lump sum. Moreover, as the stocks mentioned in the statement of affairs at £76,396 4s. 5d. have, of course, been depleted, it would be impossible and unfair to compare the realisation of the remnant of those stocks with the estimate of the stock on March 10th, 1893. I think that I can, with the exception of the items "Stock in trade" and "Trade fixtures and fittings," give reliable figures, which items I, however, think may be fairly estimated at £20,215 11s. 9d. The cash at bankers and in hand appearing in the directors' statement of affairs is substantially correct. The investments in shares, &c., amount to £31,768. The item appearing in the statement of affairs for property, £36,847 4s., includes the sum of £13,500 for goodwill at the head office and different branches, and the sum of £21,950 for patents. The item for goodwill will realise nothing, but for certain of the patents I have received an offer of £2,000, others are included in the offer of £8,500 for the Manchester and London businesses, the remaining patents being valued at £1,150. The book debts were estimated to be of the value of £37,519, but I estimate a deficiency on the whole item of £24,521. The next item is bills receivable, which, according to the statement, are estimated to produce £3,662. Of this amount £1,616 has been received, and the balance of £2,046 is valueless. I now come to an item of £13,599 14s. 6d., which is the estimated surplus from the securities in the hands of the creditors fully secured. Of this item not more than £2,500 will be received, inasmuch as it was estimated that the surplus from the sale of the Kidsgrove Works would show an excess of £5,000, but it will only show £2,500, and even part of this is for stock, &c., not included in the mortgage or in the above estimated surplus; whilst from the Cadby Hall sale it was anticipated that a surplus of £7,000 would result, and this property has been disposed of by the mortgagees for £10,500, the amount of their mortgage money and interest. I may say with reference to this property, that I instructed a well-known firm of land agents and valuers in the West End of London to value the property on my behalf, and they valued it at the sum of £6,000. I thereupon allowed the mortgagees to enter and take possession. The item for unpaid calls was estimated to produce £7,647; up to now I have succeeded in recovering £7,073, and anticipate that £100 will be realised from the remainder. After detailing certain negotiations he had entered into for the disposal of the remaining assets of the company, the chairman proceeded: You will gather from the report which I have read to you that the realisation of these assets has fallen far below the too sanguine estimate placed upon them by the directors in their statement of affairs. You will see that as all the assets at the present moment are not realised, it is practically impossible for me to give anything like a reliable estimate of what may be expected by the debenture holders in the shape of a dividend; but my estimate is that, subject to the costs of the realisation, there will be a sum of £32,000 available for distribution amongst the debenture holders, of which I estimate £3,600 will be due to the 5½ per cent. debenture holders, £18,400 will be due to the 6 per cent. debenture holders, and £10,000 to the 10 per cent. "secured" debenture stock. It is apparent upon the face of it, from the statements that I have made to you, that in no case can the debenture holders receive a full return for their investment, and although it would, of course, have afforded me greater satisfaction to have been able to give you some more or less reliable figures to-day from which I could arrive at an idea of what dividend I shall sooner or later be in a position to pay you, you will see that, under these circumstances, all I can possibly do is to lay before you—which I think you will see I have endeavoured to do—a full account of the present position of the assets existing when I took possession of what is practically your property, and also lay before you a statement showing the steps I have taken in your behalf, and in the protection of your interests.

A Debenture Holder remarked that the result of the liquidation was very disappointing, but they had to thank Mr. Leslie very heartily for the way he had put their misfortunes before them, from which he thought they had a pretty clear idea of the position. He proposed a vote of thanks to Mr. Leslie.

The motion was seconded by another debenture holder, and carried by acclamation.

The proceedings then concluded.

General Electric Power and Traction Company.

An extraordinary meeting of this company was held on Tuesday at the Cannon Street Hotel to consider the confirmation of the resolution passed at the extraordinary general meeting on the 21st ult. for winding up the company voluntarily under the provisions of the Companies Acts.

Mr. James Pender, who presided, proposed the resolution, and Mr. Immisch seconded it.

Mr. Page Hopps thought the shareholders were entitled to a little further information regarding their position and assets before they were asked finally to wind up. They had shares in the Acme and Immisch Company and the Immisch Launch Company, and he would like to know what would be done with these shares. He did not understand how any complication could arise—as appeared to be thought at the last meeting—regarding the rights of the preference and ordinary shareholders.

The Chairman stated that, as far as he was aware, the preference shareholders had a first claim on any assets which might exist.

Mr. Garcke observed that the position of the two classes of shareholders was clearly defined, and the liquidators would have no difficulty in dealing with the matter. No arrangement whatever had been made as to selling the preference shares held by them in the Acme and Immisch Company and the Immisch Launch Company.

The motion was then carried with one dissentient, and a further resolution was afterwards passed appointing Mr. E. Wilding (the accountant) and Mr. William Bulloch (the secretary) liquidators of the company, and fixing their remuneration at £150.

Richard Hornsby & Sons.

At the ordinary general meeting of this company held last Monday at the Cannon Street Hotel, Mr. James Hornsby, D.L. (the chairman) said he regretted that he could not meet the shareholders with anything better than a practical repetition of last year's report. The year opened with but gloomy prospects, and trade was uniformly bad during the first six months. It was much better during the second half-year, and in some departments they were exceptionally busy; but the improvement was too late, and not great enough to counterbalance the effects of the first six months. Added to this, competition seemed to grow keener, and in times of depression this competition seriously affected profits. Their oil-engine trade was rapidly growing, and bade fair to shortly repay the heavy expenses incident to the commencement and development of that new branch. They submitted two engines to the trials of the Royal Agricultural Society of England at Cambridge in June last, and were successful in winning both first prizes of £50 for fixed engine and £50 for portable engine.

Elmore's German and Austro-Hungarian Metal.—The profit and loss account shows a loss for the year ended December 31st, 1893, of £12,076. The directors state that the loss on trading is made up to a considerable extent by the reduction made in the values taken of the various descriptions of copper in stock, it having been deemed desirable by the German managers and auditors that these should be written down to almost their raw material value. It is also partly made up by the loss incurred on the sale of 10 tons of stock tubes, which had to be sold at the raw copper value, instead of the market value of such sized tubes. Subject to these reservations, the actual loss on trading did not exceed £600. The largeness of the profit and loss account is partly accounted for by the fact that, according to German company law, it was necessary to write off the establishment expenses, as shown in the last account, amounting to £4,471, as loss, and the depreciation on the various accounts comes to the sum of £3,300.

Coolgardie Electric Lighting Company.—According to the West Australian correspondent of the *Financial News*, this company has issued a revised prospectus, with a view to raising £7,000.

Eastern Extension, Australasia and China Telegraph.—The directors have declared an interim dividend for the quarter ended September 30th of 2s. 6d. per share, free of tax.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending December 9th, 1894, amounted to £941; week ending December 10th, 1893, £913; increase, £28; total receipts for half-year, 1894, £20,517; corresponding period, 1893, £19,188; increase, £1,329.

The Liverpool Overhead Railway Company. The traffic receipts for the week ending December 9th, 1894, amounted to £855; corresponding week last year, £606.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 7th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,084.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, December 5th.	Closing Quotation December 12th.	Business done during week ended December 12th, 1894. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	102 —105	102 —105	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	38 — 39	38 — 39	...	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 5s	£5 10s.	£5 2s.	72 — 73	71½— 72½	72½	72
2,993,560£	Do. do. Defd.	Stock	...	...	...	6¼— 6⅝	6¼— 6⅜	6⅜	...
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½% §	6½% §	11 — 11½	11 — 11½	11½	11⅜
75,000£	Do. do. 5 %, repayable June 1906	100	...	...	...	110 —114	114 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10%‖ §	... §	2 — 3	2 — 3	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	140 —150	140 —150	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½% §	2 % §	2 % §	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½— 13½	12½— 13¼	13¼	13
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	20	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½%	4 %	4 %	4¼— 4⅜	4¼— 4⅜	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9¼— 9⅜	9¼— 9⅜	...	...
30,000£	Do. do. 4½ % Debs. of £50, Nos. 1 to 1,600	...	...	...	...	105 —108%	105 —108%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	2⅝% §	8½— 9	8½— 9	8 9/16	8½
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	6½% §	15⅝— 16	15⅝— 16⅛	16 1/16	15⅝
70,000	Do. 6 % Pref.	10	6 % §	6 % §	6 % §	16½— 17	16⅜— 17½	16⅝	16⅜
102,100£	Do. 5 % Debs., repay. August, 1899	100	...	...	...	106 —110	106 —110	..	...
1,297,837£	Do. 4 % Mort. Deb.	Stock	...	...	...	118 —121	119 —122	120	119½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	15⅝— 16⅛	16 — 16½	16¼	16
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	103 —107	103 —107	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	104 —107	104 —107	...	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	117 —121	118 —122	120⅜	...
95,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —107	103 —107	...	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	104 —107	104 —107	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	104 —107	105 —108	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	107—110% xd	107 —110%	108½	108
180,227	Globe Telegraph and Trust, Ltd.	10	5¼% §	4⅞% §	4⅝% §	8⅝— 8⅞	8⅝— 8⅞	8⅞	8⅝
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15¾— 16¼	15¾— 16¼	16	15¾
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜%	21½— 22	21¾— 22¼	...	...
190,000£	Do. do. do. 5 % Debs.	100	...	...	...	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	47 — 49	47 — 49	...	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	5 — 7	5 — 7	...	...
100,000£	Do. do. 6 % Debs.	100	...	...	...	102 —106	102 —106	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	¼— ⅜	¼— ⅜	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1½— 2½	1½— 2½	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	5 % §	5 — 5¼	5⅛— 5⅜	5⅜	5
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	15 — 17	15 — 17	16	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	15 — 16	15 — 16	15⅞	15⅜
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5⅜— 5⅞	5¾— 6	5⅞	5¾
1,000,000£	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	110 —113	110 —113	...	...
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	7/16— 9/16	7/16— 9/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	104 —107	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	0 %	3 — 5	3 — 5	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	104 —109	107 —111	109½	106½
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2 — 3	1 — 2	1⅝	...
146,733£	Do. do. 5 % Debs.	Stock	...	...	...	88 — 94	88 — 94	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	0 %	3 — 5	3 — 5	...	...
238,300£	Do. do. do. 5 % Debs.	100	...	...	...	100 —103	101 —104	103	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½— 2½	1½— 2½	1⅝	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	100 —105	100 —105	...	...
64,245	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	2½%	11 — 11½xd	11½— 12	11⅝	11½
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	6½— 7 xd	6½— 7	6¾	6½
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	5 — 5½	5 — 5½	5 5/16	5
171,900£	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	101 —105	101 —105	...	...
214,800£	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	101 —105	101 —105	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	⅜%	1 — 1⅛xd	1 — 1⅛	1	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	10⅜— 11⅛xd	10⅜— 11¼	11	10⅜
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	..	9 — 10 xd	9 — 10	...	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	108 —111	108 —111	...	...
$1,211,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	112 —118	112 —118	...	...
166,900£	Do. do. 6 % Ster. Bonds.	100	...	...	...	102 —104	102 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4½— 5½	4½— 5½	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	...	13 — 14	13½— 14½	13⅞	13½
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	...	6 %	6 %	14¾— 15¼	14¾— 15¼	15⅛	14⅝
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	131 —133	132 —135	...	...
50,000	†Liverpool Electric Supply, all paid	5	4½%	5 %	5 %	7⅜ — 7½	7⅜ — 7⅝	7 11/16	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	1 %	2 %	2½%	10 — 10½	9¾— 10¼	10⅜	10
100,000£	Do. 5% Deb., bonds of £10, £20, £40	...	...	...	...	... — ... xd	... — ...	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	...	...	...	114 —116	115 —117	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	6½— 7⅛	7 — 7½	7 1/16	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7¼%	4½%	7⅞— 8¼	7⅞— 8¼	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8¼— 9	8½— 9	...	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½%	4 %	7½— 7⅝	7½— 7⅝	7½	7⅜

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, Dec. 5th.	Closing Quotation, Dec. 12th.	Business done during week ended Dec. 12th, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2⅜ — 2⅝	2⅜ — 2⅝	2⅝	2 9/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2¼ — 2½	2¼ — 2½	...	...
125,000£	Do. do. 4½ % Deb.	Stock	...	...	...	110 —113	111 —114	113	...
630,000£	City and South London Railway	Stock	...	⅝%	⅝%	40 — 42	41 — 43	42½	41⅝
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	7 % §	2¾ — 3¼	2¾ — 3¼	...	...
50,000£	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	96 —101	96 —101	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	⅜ — ⅝	¼ — ½	⅜	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1½ — 2	1½ — 2	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd., 1 to 66,750 ...	2	*nil*	*nil*	*nil*	⅛ — ¼	⅛ — ¼	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	1¼ — 1½	1⅛ — 1⅜	1 5/16	1 3/16
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	1 — 1⅛	⅞ — 1⅛	1	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½ — 1½	½ — 1½	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½ — 7½	6½ — 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	5 %	8½ — 9½	8½ — 9½	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	25½ — 26½	25½ — 26½	26	...
200,000£	Do. do. do. 4½ % Deb., 1896	100	...	...	...	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	8 — 8½	8½ — 8⅝	8 9/16	...
6,295	† Do. do. Pref., £8 paid	10	...	...	...	13 — 13¼	13 — 13¼	...	...
	Swan United Electric Light, Ltd.	...	11 % §	10 % §	7½% §	... — ...	... — ...	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	41 — 43	41 — 43	42⅞	41¾
150,000£	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	106 —109	106 —109	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2¼ — 2½	2¼ — 2½	2⅜	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50 % for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0 %; 1891—7 %; 1890—8 %.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅞—6.
Electric Construction Corporation, 6 % Debentures, 93—97.
Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.
House-to-House Company (£5 paid), 2¼—2½.
Do. do. 7 % Preference, of £5, 6⅛—6⅜.
Do. do. 6 % Debentures of £100, 101—103.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4¾—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅜.
Liverpool Electric Supply, £5 (fully paid), 6⅜—6½.
London Electric Supply Corporation, £5 Ordinary, ⅞—1¼.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

PROCEEDINGS OF SOCIETIES.

The Northern Society of Electrical Engineers.

ON THE COMMERCIAL POSSIBILITIES OF ACCUMULATORS FOR TRAMCAR TRACTION, CONSIDERED AS A MUNICIPAL UNDERTAKING. By ALFRED H. GIBBINGS, Member. Read December 10th, 1894.

INTRODUCTORY REMARKS.

During the past twelve months I have had occasion to consider the question of electric traction in each of the many forms in which it is placed before the public in general and municipalities in particular, by the interested advocates of the respective systems. The fact is, the Corporation of Hull had it in contemplation to apply for an Act of Parliament empowering them to acquire and work the tramway system of their own borough. I was therefore requested by my committee to place before them a report as to what had already been done in this country in the direction of electric traction, so that at least as far as this form of traction was concerned they would be in a position to consider each of the different methods on its own merits.

In my final report to the committee I submitted that, in my judgment, accumulators would offer greater advantages to the town than either of the other forms. The technical journals, however, in which this recommendation was published, did not, I am sorry to say, include the whole of my report to the corporation. The consequence was (as might, indeed, have been anticipated) that several criticisms were passed questioning the commercial and financial results of the method I recommended, whereas, in fact, these results were the determining factors in the conclusion to which I ultimately arrived.

When the subject of electric traction is seriously approached by electrical engineers, corporations, and companies, the usual course of procedure and invesigation is to consider the relative intrinsic merits of the different systems apart from the very important question of the conditions under which the method is to be employed. Each of the three forms of electric traction, namely, the underground channel or conduit system, overhead wires or trolley system, and accumulators, has its own very able exponents in the technical press and elsewhere, but, unfortunately, the majority of the writers are themselves interested in the system which they advocate, and for this reason such papers cannot be considered to have the same value as if the authors had been entirely disinterested experts.

I am safe, perhaps, in admitting that the overhead wire or trolley system has proved a greater practical and financial success than either of the others. This statement, however, refers to cases in which a special plant has been put down to generate energy for the specific purpose of working whichever system has been adopted, and as far as my knowledge extends, every comparison between the three systems in regard to cost and working efficiency has been made under these special circumstances. I am, however, digressing a little, and will now resume.

The recommendation to adopt accumulators, which I ultimately submitted to the Corporation of Hull, was based upon an entirely new departure, in the working out of which I have been very interested. My object in bringing the subject before your notice in this paper is that my reasons and conclusions may be fully discussed, in the hope that a new light may be thrown upon municipal undertakings. I have come to the conclusion that the secret of success lies not so much in the adoption of any particular method of electric traction, however superior, as it does in enlisting and utilising services which other enterprises can be made to contribute. Separately, they may be only just paying their way, but, combined, it will probably become possible to make an exceptional success of both.

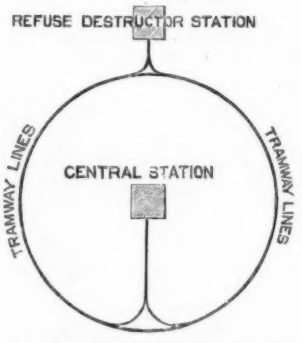
Let me clear the way, in the first place, by removing any misconceptions there may be that the circumstances and conditions of the town of Hull relative to electric traction are unique in their nature. Such is not the case. There are, indeed, dead level roads, and these certainly offer many advantages to accumulator traction which might not apply elsewhere. On the other hand, there are many dock bridges which open and close, and these present a mechanical difficulty which, however, can be surmounted without stopping the running of the cars, as it is very seldom that two of the docks' gates are open at the same time. But, in point of fact, these special features do not affect the general question we are now considering.

The basis on which I now propose to consider the subject of my paper has for its essential feature the possibilities in economical management and working which are within the power of municipal corporations. Municipal corporations are, in this respect, widely different from private or public companies, inasmuch as they are responsible, not for one business alone, but for many and varied undertakings. A public company restricted to the narrow limits of its single enterprise, will, of course, select a system which is likely to show the lowest working costs, and such a selection will be to the best interests of the shareholders. But municipal corporations should have wider views. They have many businesses to conduct in the interests of the ratepayers. The system, therefore, to be selected by a municipal corporation is that which has the greatest tendency to enhance the value and increase the profits of other departments of the corporation. The cost of working, considered from this point of view,

though, perhaps, actually heavy and large, may be *relatively* small.

I will now proceed to a short general analysis of the combination of refuse destruction, electric tramway service, and electric lighting on the low tension system.

For the purposes of illustrating the general arrangement, I beg to draw your attention to the accompanying diagram. The large circle of lines represents the tramcar route, with the destructor station on the confines of the town, and the electric lighting station in the centre.



Power from Refuse Destruction.

It is now a generally admitted fact that, given modern improvements for the generation of steam, some power can be obtained from refuse destruction. The publication of Mr. Charles Jones's book on "Refuse Destructors" has thrown light upon a subject which has hitherto been neglected by engineers, while the popular articles by Mr. Thomas Tomlinson (Electrical Review) have brought new possibilities before the electrical engineer.

To sum up the whole of the evidence contained in Mr. Jones's work, I find that out of 50 destructors at work destroying from 3½ tons to 10 tons per cell, the power obtained varies from 5 to 7 H.P. per cell. This power has been generated under conditions for raising steam which have had to be, and will always have to be, modified and made compatible with the complete destruction of the refuse from a sanitary point of view.

The question therefore arises: What is the best use to which this power may be put? Hitherto it has found its solution for the most part in the working of mortar mills and stone breakers, or as a subsidiary power to an electric lighting station, possibly producing sufficient power for day-load purposes. These applications, however, while their advantages are not denied, do not use one half of the available power, for the simple reason that most destructors are in operation the whole of the 24 hours, and the hot gases are at night perforce turned into a bye-pass flue, and so far wasted.

Under every scheme, which is at present being tried, there is as much power lost as utilised; but in the scheme to which I wish to draw your attention this evening, the whole available power is laid under contribution day and night, without intermission as far, of course, as the usual engineering considerations will allow.

Now this is a very important point, upon which I wish to lay particular stress.

The difference therefore between my proposition and the use to which the power has already been applied, or, in other words, between my scheme and the schemes for utilising the power for the day load of electric lighting stations, may be stated as the difference between *horse-power* and *horse-power-hours*. The available H.P., with a variable demand, is practically an unknown quantity, whereas the utilisation of the available H.P. continuously over a stated and pre-arranged number of hours is a definite quantity, and one upon which calculations can be made.

The suggested probable economy in the first case is a very doubtful matter; but under definite conditions the problem is resolved into calculating the usual losses which always occur through the transmission and transformation of power. Where the power is utilised as an auxiliary to electric lighting, one other very serious drawback occurs, which I just briefly point out in passing. I refer to the "standing by" of the main boilers, and their consequent daily cooling during the time that the destructor boilers are supplying the steam. The period of the earning capacity of the former is thereby rendered very short, and the increased economy of working by the combination is practically neutralised by being swallowed up in interest on the capital outlay. In addition the boilers are deteriorated by being alternately cold and hot.

Application of the Power.

In a paper of this description it is quite unnecessary to deal in a detailed manner with all the applications to which it is possible to put the power derived from the destruction of refuse. The effectiveness of this power depends largely on the quantity and nature of the refuse to be destroyed, and this, again, varies enormously in different towns. But I have already pointed out that, according to the best authorities and our own knowledge of the relative value of fuels as heat producing agents, it must be admitted that a refuse destructor cannot be depended upon without the extraneous aid of other fuel to provide its maximum power at any given time. I must not be understood to say that an admissible and economical arrangement might not be devised where coal, for instance, might be used as an auxiliary fuel; but, taking the refuse destructor on its own capabilities alone, we may safely assume that, as a power producer, it is limited to this extent, namely:—

That it yields a mean steady power only;

or, in other words,

That it cannot be depended upon for sudden emergencies.

We must take it for granted, at the outset, I think, that in every case the refuse destructor may be depended upon to provide a certain *minimum* power. This minimum power must be adequate to meet the demand made upon it, or, in other words, the plant to which it is proposed to apply the power must be so designed and arranged that *at no time shall a sudden and unexpected demand* be made upon the destructor which it is incapable of meeting.

In the town of Hull about 250 tons of miscellaneous refuse are destroyed weekly. This is a small quantity compared with that of other provincial towns. A large portion is composed of dry shop-refuse, such as paper, straw, wood and ashes, while it is not an infrequent occurrence to have to destroy whole ship cargoes of condemned fruits, vegetables, and fish. From observations taken, I am well within the mark in estimating that with the necessary alterations to the present destructor we could obtain a continuous power of 45 I.H.P. This 45 I.H.P. would give at least 40·5 E.H.P. at an efficiency of electrical machinery of only 90 per cent., or a continuous output of 400 ampères at 75 volts, for it must be borne in mind that, under the scheme I am unfolding, the electrical machinery would be designed to always work at full load. This arrangement would be amply sufficient to charge batteries of 25 cells, always keeping a certain number of batteries in parallel according to the rate of charge.

Of course, the number of batteries and their size would depend upon the size of car to be propelled, and I have already pointed out that the power at the destructor station can be supplied continuously for the 24 hours. This would be equivalent to doubling the capacity of the plant, as the batteries charged during the night would meet the requirements of the tramcars for half the succeeding day. This power would charge a sufficient number of accumulators to run from about one-half to three-quarters of the trams, according to whether the service consisted of 12 or more trams in the hour on the different routes. The remaining portion could be conveniently and economically provided for by supplying another charging station with power from the machines at the central electric lighting station, which machines would be available for this purpose during the day or night, excepting only at the time of maximum demand.

In considering the whole matter, I had brought before my notice what had already been done with regard to thermal storage. There may be possibilities in thermal storage which are not yet matters of common knowledge. This, of course, may be especially the case where sudden demands for abnormal power for short periods would be made, as in that case the steady and continuous power generated might be stored.

But the only reliable working statistics we have are those connected with a steam tramway in India, where the engines obtain sufficient power for one journey from a reservoir of high pressure steam. It can easily be seen, however, that the hot climate of that country must conduce very largely to the success of the system, as radiation must be at a much less rate than would be the case in England. Indeed an English winter might render such a system quite inoperative.

Reverting to the two other alternatives, namely, the overhead cable or trolley system and the underground conduit system, the *advantages* of which mainly consist in economy of working (plant for plant), I may mention a few of the *disadvantages* (and consequent expense) attendant upon these systems which do not occur with the use of accumulators.

1. Irregular demands upon the generating plant.
2. Greater wear and tear of the machinery.
3. Capacity of generating plant must be equal to all possible demand upon it.
4. Plant standing idle when cars are not running.
5. Stringent requirements of the Board of Trade as to insulation and periodical tests.
6. Greater original outlay of capital.
7. Impossible to economically use the power which the electric lighting station might contribute during the day.
8. Inability of the refuse destructor station to supply *the whole of* the power required, hence,
9. Necessity to erect independent central generating station to supply *additional* power required.
10. For the reasons contained in 8 and 9, very little, if any, advantage in point of economical working would arise from the aid of the refuse destructor.

The foregoing list of disadvantages is serious enough, but over and above all these I may point out that the power from a refuse destructor when applied to an overhead or underground system would only complicate what is merely a simple scheme. In fact, it would be more economical to put down one complete generating plant for the tramcars, appropriating the destructor power to some other purpose, where, as I have already mentioned, the whole power obtainable as calculated in horse-power hours would be turned to more remunerative account.

The most serious item to be considered is, after all, that of capital expenditure. A heavy original outlay runs away with so much of the profit in the case of municipalities in providing interest and sinking fund. Now the capital expenditure, be it observed, for the complete equipment of accumulator cars, is usually from 50 per cent. to 75 per

cent. only of that required for the overhead cable system, according to the track mileage. If the accumulator system can be arranged and worked so that the entire depreciation of the accumulators can be written off per annum out of lower working costs than are possible with either of the other systems, then it is clear that traction by accumulators would be the most highly remunerative system of any form of traction yet devised.

The Advantages of Accumulators.

I have already pointed out that one of the greatest advantages of accumulators for electric traction purposes lies in the fact that the power of a refuse destructor may be utilised to the full, and that in consequence the cost of generating the power (both with regard to fuel and labour) would be extremely small. But if the scheme ended here the advantages would perhaps scarcely justify the especial prominence I have given to it. It is only as the destructor is brought into combination with the central station electric lighting plant that the matter becomes supremely worthy of consideration. I am of opinion, in the first place, that no town has sufficient refuse to supply of itself the whole power required to run its tramcar service, whether by accumulators or other system. Even supposing that sufficient power could be so obtained, it would necessitate an additional capital outlay on buildings, machinery, &c., so great that it would practically be the same as for an electrical station independently worked. But where merely horse-power is available, the necessary plant could readily be accommodated. The chief function and value in that case would consist in its being a "relief" station, which would obviate the running of all cars to one point only for recharging purposes. If there were more than one refuse destructor in a town, each, of course, could be used to form a relief station according to the number and frequency of the cars.

I have so far endeavoured to point out the advantages and uses of accumulators in connection with the utilisation of the power derivable from refuse destruction. I now proceed to consider a far more important matter, namely, the advantages arising from charging accumulators for electric traction by means of the available and otherwise idle plant at a low tension electric lighting central station.

These advantages are based upon the following fact:—

The cell charging can be stopped at the hour when the heavy lighting load comes on, and the full capacity of the plant can then be used for lighting purposes.

This at the first glance may, perhaps, appear a very small advantage, but its full significance consists in the fact that it provides a day load for the central electric lighting station. I have no need to here describe the *modus operandi*; suffice it to say that low tension central stations are designed for charging accumulators, and by means of independent connections those machines not running in the day or night time could be employed in charging separate accumulators for the tramcar service. As the electric lighting load came on so the different machines would be transferred from the tramcar plant to the main switchboard, and *vice versa*.

The question now is, What does this arrangement actually mean both to the tramcar and the electric lighting enterprises?

The tramcar enterprise would benefit in many ways, viz.:—

1. Less capital would be required, not having to provide independent dynamos and engines.

2. There would be, of course, correspondingly less interest and sinking fund liabilities.

3. Such expenditure as would fall under depreciation of plant, repairs, rents, rates and taxes, wages of boiler and engine attendants, &c., would be equitably divided between the electric lighting and the tramcar concerns.

4. The management of the tramcars, whilst under the supervision of an official and staff, would also be controlled by a separate committee, which would act conjointly with the Electric Lighting Committee.

It must be quite clear, therefore, that co-operation must very largely reduce the working costs of a tramcar system. The cost per unit, whether we calculate per horse-power-hour per car mile, or on any other basis, must be greater where the whole cost of management and working has to be borne by the tramcar service alone, than will be the case where, by using the resources of the electric lighting plant, handsome profits are made in what I may term "spare time."

To what extent this co-operation might be developed it is difficult to say, but the fact that each enterprise would save considerable expense to the other is perfectly obvious.

With regard to the electric lighting concern, the acquisition of a substantial day load is of the utmost possible consequence. For the purposes of this paper it will be better to assume that this department merely charges (as an electric lighting enterprise pure and simple) for the current which it can generate and sell. That is, I do not wish to complicate what I have to say by assuming any arrangement between the electric lighting and tramcar committees with regard to sharing the proportions of the costs under the various items common to both enterprises. It will be sufficient if we assume that:—

1. The Electric Light Committee retain their independent position, and make a definite charge per unit for all current supplied.

2. That this output is merely considered as a day load.

The endeavour to solve the problem of a day load for the central station has resulted in the suggestion of many different methods, but most of these methods at the best would only make use of a very small proportion of the available power. In common with other central station engineers I have had the problem before me, and a few months ago I endeavoured to show, in a contribution to the Electrical Review, how far the various methods of charging the public for electricity from a central station tended in the direction of encouraging a day load.

In the course of my analysis in that article, under the heading of "The Works Cost," I dealt with the available horse-power of a central station, and I cannot do better than read the paragraph:—"Let us assume that the available horse-power of a station is 1,000. Multiplying this by the total number of hours (8,760) in the year, gives 8,760,000 horse-power-hours. Assuming, on the other hand, that the full capacity of the plant is used on the average three hours only per day, then the total number of actual horse-power hours = 1,095,000, or one-eighth of the absolute capacity. As an assumption this errs, if anything, on the same side, as very few central stations, in fact, are yet reaching the one-eighth of their full capacity in the year. We must now consider this unused available horse-power side by side with those items of cost which would not practically be increased in the sum by generating seven-eighths available output.

"The items are as follows:—

"1. Wages (except outdoor staff).

"2. Salaries.

"3. Repairs and maintenance.

"4. Rent, rates and taxes.

"5. Sinking fund.

"6. Interest on capital.

"It will readily be admitted that these are the expenses which really affect the cost per unit delivered to consumer. Yet these remain, to all intents and purposes, constant; practically, neither more nor less, even when the plant is being utilised to the full. The result, of course, is, that where the output is increased eight-fold, the rate of cost per unit delivered, so far as these items are concerned, will be reduced to one-eighth."

The remarks I have now quoted with regard to the methods of charging for current are equally true in reference to the arrangement which we are now considering. As an example, I will give actual figures from the working of the electric lighting station at Hull. These may be absolutely depended upon, as we weigh all coal, all ashes, and measure everything consumed. The units generated and delivered are checked in four ways—*first*, by Aron meters in the circuit from the dynamo to the switchboard; *second*, by the working out of daily load curves taken from readings on the ammeters; *third*, by Edmondson meter in the main omnibus bars between the switchboard and the several feeders; *fourth*, by quarterly comparison of the consumers' meter readings. All these we find agree within a small percentage.

Our lightest weekly output during this summer cost us ·97d. per unit delivered (not generated), including coal at 14s. per ton, and oil, water, waste, and all stores. Our heaviest weekly output during this winter has cost us ·60d. per unit for the same items.

Now, with regard to the standing charges just referred to, if we multiply the heaviest weekly output by 52, or, in other words, if we assume the maximum weekly output as the average weekly output, I find that the proportionate cost of the standing charges comes to 1·84d. per unit. Adding both these costs together, that is, the generating cost and the standing charges cost, we get:—

Generating cost	·60d.
Standing charges cost	1·84d.
Total	2·44d.

as the representative total cost per unit for one week, and I have no need to add that I only wish the figures were true for every week in the year.

The maximum electrical power used during this model week was 450 for an average of three hours per day, or 9,450 E.H.P. hours out of a possible 75,600.

Now, a minimum number of small cars, say 30, averaging 10 E.H.P. each, would give (neglecting charging losses) 300 E.H.P., which for 90 hours in the week is equivalent to 27,000 E.H.P. hours, or an increased output of at least three times the usual quantity. As the power required by the tramcars would not vary with the season of the year, but would remain fairly constant, it is possible that this supply would form by far the largest factor of the output for some years.

You will at once see my object in giving you these figures. The generating cost, of course, will remain the same, viz., ·60d., but the standing charges cost will be reduced to one-third, and the gross cost per unit becomes 1·21d. only for all current generated.

This figure gives us a very high efficiency, in fact, the very highest efficiency which has ever been obtained from any electric lighting central station in the United Kingdom, or, I venture to say, anywhere in the world. This demonstrates clearly what the co-operation of accumulator cars will do for an electric lighting station, and it may be definitely stated that the combination guarantees a better load factor for every week throughout the year than is obtained by the highest weekly output of the electric lighting alone. It would mean that an enormous profit would accrue to the electric lighting business itself, if only 3d. per unit were charged, and the first possibility which is immediately suggested is that of the great reduction which might be effected in the usual price per unit for current. But we must not forget that this possibility is essentially due to the creation of a magnificent day and night load. I am of opinion, therefore, that the standing charges rate should not be divided equally between the tramcar and the electric lighting concerns, but in the inverse ratio of their demand in units throughout the year. In thus charging the users of the electric light with the larger proportion of the standing costs, it would be possible to confer a still greater benefit on the traction enterprise by bringing the whole of its charges to within a 1d. per unit. This price, which includes interest and sinking fund, capital, wages, and power, as far as the generating machinery is concerned, will be found to be a much lower figure than has ever been obtained with any system.

The foregoing arrangement does not necessitate that the traction accumulator cells should be charged at the electric lighting central station. The nearer the charging depôt is to the central station, so

much the better, in order to avoid loss in transmission and outlay in cables, but it is not an indispensable condition—a special set of cables could readily be laid to any convenient spot. The system of low tension supply will generally allow and admit of additional cables being easily laid to any point within the area of distribution.

You will have observed that the arrangement therein suggested is essentially based upon those facts of which we, as engineers, are certain. I have endeavoured to entirely eliminate dubious or insufficiently tested possibilities, such as thermal storage, and I have avoided the unnecessary procedure of basing my proof upon comparisons of the working cost per car mile of the different systems, as such figures are generally misleading, and in most cases do not form any proof at all. Admitting and including the heavy depreciation of the accumulator plates, it has been my object to show how accumulator traction can be worked cheaper and more satisfactorily than the other two systems. Hence my ideas are placed before you rather in the abstract than in the concrete. With reference to my figures representing the power obtainable from our refuse destructor, or, for that matter, from any other refuse destructor, providing the requisite quantity of refuse is present, I merely wish to point out that Mr. Jones, of Ealing, estimates for the same number of cells, destroying the same quantity of refuse as at Hull, a continuous power of 50 I.H.P., while I have placed my figures at 45 I.H.P. The refuse at Hull is, in fact, of a drier and more combustible nature than that at Ealing, so that my estimate may be taken as well within the mark. I have had the advantage of seeing the Ealing Destructor Works, and my assertions, therefore, may be taken with every degree of assurance.

I have now endeavoured to point out, or indicate in this paper, a few features in connection with municipal enterprise, which are well worth consideration. I do not for a moment say that the particular instance I have given, and which I have found would be so particularly to our advantage at Hull, is one which in all respects would be found equally advantageous in other towns. But it is the co-operation of departments under municipal control which might be arranged without in any way interfering with the carrying out of the regular or specific work, which each department had been created to perform.

The tendency, of course, is already in this direction, and many towns are attempting to make some use out of the destruction of their refuse.

But there is no reason why such combinations should not be more extensively made, and to this end I have endeavoured to show accumulators, as applied to electric traction, can at the present time be turned to remunerative account.

The Académie des Sciences.

Meeting of October 15th, 1894.

On the Degree of Incandescence of Lamps. (Note by M. A. Crova.)

This can be determined accurately by means of a spectrophotometer, but, for practical purposes, it can be obtained with sufficient precision by the method which I have proposed, and which was recommended by the Congress of Electricians in 1889.* The luminous intensity, as compared with the carcel, is determined by interposing before the eye a trough containing the mixture of chloride of nickel and perchloride of iron, in proportions allowing of the passage of part of the radiations comprised between the wave lengths, 630 and 534, with a well-defined maximum of 582; a second determination is made by placing before the eye a red glass, which transmits the radiations comprised between the red extremity of the spectrum and the vicinity of the spectral line, D; the first determination gives the value in carcels of the source studied; the ratio of the first to the second gives the degree of incandescence. I have shown† that if we compare two lights of different tints, the total intensities are in the same ratio as the intensities measured within the limits of the spectrum, the wave length of which is 582; thus it is very convenient and very correct to make photometric determinations by means of the trough 582; in fact, the two sources to be compared have not, as a rule, the same tints, and the solution 582 rendering them identical, the determination is more exact; the field of a carcel at 1 metre is too intense, and the interposition of the trough weakens it, so as to bring out very clearly in relief the slightest differences of the two luminous surfaces of the photometric screen.‡

As the employment of electric lamps and intense gas jets is becoming more and more general, the application of the method that I have proposed enables us to ascertain, without difficulty, the conditions of working of the lamps that give the best results.

A few examples will show the utility of these determinations:—

For an arc lamp, the degree of incandescence varied from 1·5 to 1·7, the electric work § absorbed being respectively 1,509 and 1,660 watts.

For a 16-candle incandescence lamp, this degree varied from 1·05 to 1·33, according as the lamp is more or less over-run.

For a Bourbouze lamp, with a platinum hood, the degree of incandescence, which is less than unity for low outputs, increases with the consumption of gas and compressed air, and, at a sufficiently high *régime*, the degree of incandescence equals 1, which is that of the carcel.

The study of the Auer burner furnishes interesting results. The photometric power, the degree of incandescence, and the consumption of gas in the lighting of the Auer burner that I used, gave the following results, which were taken from a considerable number of determinations:—

Luminous intensities in carcels	4·42	5·23	5·35
Degree of incandescence	1·30	1·41	1·47
Consumption of gas, in litres per hour...	93	105	102
Consumption in litres per carcel-hour ...	21	20	19

We see that the photometric power increases with the degree of incandescence, which is in accordance with the principles of the emission of radiations by incandescent bodies.

The consumption of gas per hour increasing, the degree of incandescence, low at starting, increases continually as well as the photometric power up to a certain limit, beyond which a part of the gas, which becomes more and more considerable, burns uselessly without contributing to the heating of the tissue of refractory earths that constitutes the hood of this burner; it is, therefore, advantageous to push the Auer burner to the degree of incandescence that it cannot exceed, whatever may be the consumption of gas for the lighting. The other intensifying burners may be studied in a similar manner, and accurate data arrived at as to the best *régime* at which they should burn. The case is very different with gas burning in an ordinary Bengel burner.

In fact, in the Auer burner, and other similar burners, the quantity of refractory material contained in the lamp is constant, and the maximum efficiency corresponds to the highest temperature that it can attain in a Bunsen burner. In the Bengel burner, on the contrary, part of the gas is burned outside and inside the cylindrical mass of gas which escapes through the crown of holes, without any deposit of carbon, with the production of a bluish flame, which may be disregarded from a photometric point of view; the high temperature which is produced by this combustion without effective light brings to incandescence the molecules of carbon given off from the carburets of hydrogen contained in the mass of gas comprised between the two surfaces of combustion, and which are the real source of light, as shown in my paper on photometry.*

The quantity of incandescent carbon that furnishes the light is a fraction of the total quantity of carbon that is contained in the gas in combustion, and is smaller in proportion as the flame is lower; if the latter is sufficiently low, the whole of the gas burns blue, without producing any effective light.

As the output of the burner increases, the relative quantity of carbon liberated increases; the degree of incandescence slightly decreases, and the luminous efficiency increases rapidly up to a maximum which corresponds to the moment when the flame becomes smoky. A similar result is obtained with the standard Carcel, the output of which is varied by raising or lowering the wick.

With the Bengel burner I employed, I obtained the following results:—

Luminous intensities in carcels.	Consumption of gas. In litres per hour.	In litres per carcel hour.
·2 ...	56 ...	280
·4 ...	78 ...	195
·6 ...	95 ...	158
·8 ...	108 ...	135
1·0 ...	120 ...	120
1·2 ...	131 ...	100

Above 131 litres per hour the flame becomes smoky. From the above considerations, it follows:—

1. That, if we increase in a hydro-carburet burner the quantity of fuel burnt per hour, the luminous efficiency increases, but the degree of incandescence slightly diminishes up to a maximum efficiency, which must not be exceeded.

2. That for lamps in which the refractory material brought to incandescence has a fixed value independent of the consumption of combustible material, the maximum efficiency corresponds to the minimum quantity of combustible material that has to be burnt in order to obtain the maximum degree of incandescence.

* "Compte Rendu des Travaux du Congrès International des Electriciens en 1889," p. 210, in which will be found the explanation of solution 582.

† "Comparaisons Photometriques des Sources Lumineuses de Teintes Différentes. (*Comptes Rendus*, Vol. xciii., p. 512.)

‡ M. Pellin has constructed, according to my instructions, a sliding scale that can be adapted to any photometer, by means of which the indications can very conveniently be made.

§ The term *power* should be used instead of *work*, work being measured by joules and not by watts.

NEW PATENTS—1894.

22,856. "Instruments for measuring the frequency of alternating or periodically varying electrical currents." H. C. Haycraft. Dated November 26th.

22,866. "A regulating lever-action (dummy) 'sounder' practice telegraph instrument." F. E. Morriss. Dated November 26th.

22,880. "Electric arc lamp." R. M. Trille. Dated November 26th.

22,883. "Improvements in electrical measuring instruments." G. Binswanger and E. Stanley. Dated November 26th.

22,890. "Improvements in apparatus for the manipulation of electric or lime-light boxes, scenes, curtains, and wings operated by electric current." A. Taylor. Dated November 26th.

22,918. "An improved form of gas or electrically-heated iron." T. B. Grant. Dated November 26th.

22,919. "An electrically driven hydro-extractor." T. B. Grant. Dated November 26th.

* "Etude Photométrique de Quelques Sources Lumineuses." (*Comptes Rendus*, Vol. lxvi., p. 1,343.)

22,965. "Improvements in or relating to electrically heating metal or other conducting bodies or welding metals electrically. W. P. Thompson. (Communicated by C. L. Coffin, United States.) Dated November 27th. (*Complete.*)

22,966. "Improvements in or relating to the production of compounds applicable for such uses as for paints for electric insulating and water-proofing, as substitutes for vulcanisable rubber and gum compounds, and for other purposes." W. P. Thompson. (Communicated by W. Griscom, jun., United States.) Dated November 27th. (*Complete.*)

22,973. "Improvements in and relating to storage batteries." C. S. W. Brown. Dated November 27th.

22,985. "Improvement in the means of fastening to incandescent electric or other lamps and globes any shade or ray diffuser. E. Oldenbourg. Dated November 27th.

22,986. "Improvements in and relating to primary batteries for producing portable electricity for light and power and other purposes." C. J. Hubbell. Dated November 27th. (*Complete.*)

23,012. "Electric signalling systems." H. E. Walter. Dated November 27th. (*Complete.*)

23,083. "Electrical and mechanical appliances for extracting shives, &c., from casks and other vessels and examining them inside." J. T. Thompson and A. Slatter. Dated November 28th.

23,086. "Improved electric traction system and apparatus therefor." R. Kennedy. Dated November 28th.

23,098. "Improvements in the feed-regulating mechanism of electric arc lamps." W. K. Partington. Dated November 28th.

23,099. "An insulator to prevent vibration or humming, and also loss of current or insulation by atmospheric leakage caused by spiders and the like, web spinning under flange or shed." W. S. Cottis. Dated November 28th.

23,117. "An improved electrolytic process and apparatus for obtaining rich alloys of the metals of the alkalies or alkali earths and the production of halogen elements." L. P. Hulin. [Date applied for under Patents, &c., Act, 1883, Sec. 103, May 5th, 1894, being date of application in France.] Dated November 28th.

23,159. "Improvements in and relating to electric brushes and such like." E. L. Levetus. Dated November 29th.

23,160. "Improvements in and relating to primary batteries and such like." E. L. Levetus. Dated November 29th.

23,177. "Improvements in dynamos." A. G. New and A. J. Mayne. Dated November 29th.

23,198. "Process for the treatment of certain metallic alloys for the manufacture of elements for voltaic batteries and caustic alkalies or their derivatives." L. P. Hulin. [Date applied for under Patents, &c., Act, 1883, Sec. 103, May 7th, 1894, being date of application in France.] Dated November 29th.

23,203. "Improvements in the application of springs for electrical switches and other purposes." W. T. Burbey. Dated November 29th.

23,219. "Improvements in the method of fixing electric arc lamps, with special reference to ease and safety for adjustment, trimming, &c." G. M. Harriss. Dated November 30th.

23,250. "Improvements in gauges of electric exhaustion, positive and negative, caused by surroundings, buildings, or atmosphere." E. S. d'Odiardi and E. S. d'Odiardi. Dated November 30th.

23,279. "Improvements in electrically-propelled carriages for common roads." F. King. Dated November 30th.

23,294. "An improved electrical lamp." E. Grahame. Dated December 1st.

23,297. "Improvements in and relating to an apparatus and a method for causing chemical changes of gases and mixtures of gases by dark electric discharges." N. van der Sleen and A. Schnellen. Dated December 1st.

23,314. "Improvements in fuel economisers." A. Lowcock. Dated December 1st.

23,315. "Improvements in fuel economisers." A. Lowcock. Dated December 1st.

23,354. "Improvements in and connected with the electric lighting and heating and also the ventilation of railway carriages and other vehicles." E. J. Preston, of the firm of J. Stone & Co., and A. B. Gill. Dated December 1st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

19,283. "An electric heater." E. C. de Segundo and W. Derham. Dated October 13th. Claim:—An electric heater, consisting of an inner casing covered by a layer of asbestos fabric, or equivalent material, on which is coiled a wire in convolutions at intervals apart, and an outer casing and end covers enclosing the annular space containing the wire, the ends of which are connected to suitable conductors, substantially as described.

20,793. "Improvements in recording instruments for electric telegraphs." A. Muirhead. Dated November 2nd. Has for its object to arrange or combine the component parts of such an instrument that adjustments can be more readily effected than hitherto, and whereby the removal of the signal coil, or other working parts of the instrument, is facilitated in case of accident, damage, or when otherwise required. 3 claims.

22,817. "Improvements in electro-meters." H. Aron. Dated November 28th. Is more particularly to prevent false indications of the differential counting apparatus of electrical energy. 4 claims.

23,083. "Improvements in apparatus for recording electric currents." H. Aron. Dated December 1st. Relates to that class of apparatus in which the amount of electrical current is measured by the deviations of two clockworks or wheel trains, one of which is accelerated or retarded in its normal speed by the influence of the current. 5 claims.

23,221. "Improvements in sockets or receptacles and regulators for incandescent electric lamps." H. H. Lake. (Communicated from abroad by C. A. Hussey and C. C. Edey, both of New York.) Dated December 2nd. The regulator comprises a number of pencils or rods of material having a high electrical resistance, and made preferably by mixing together a material of low resistance, such, for instance, as plumbago, with a material of high resistance, such, for instance, as peroxide of manganese. It is understood that they shall be introduced one at a time into the electric circuit of a lamp fitted to the socket or receptacle for the purpose of varying the brilliancy of the light, and hence each of the pencils or rods must be of a different resistance from the others. 3 claims.

23,366. "Improvements in phonographs." H. J. Lioret. Dated December 5th. Relates, in the first instance, to the construction of the cylinder or roll serving to receive the impressions of the recording stylus or point which is carried by the vibrating plate in front of which one speaks; the improvements permit of such engraved cylinder being employed as a matrix for reproducing the same impressions a large number of times on other cylinders; in the second place, the improvements relate to the method of mounting the cylinders; in the third place, they relate to the arrangement of the receiving stylus and the sounding box to which it is adapted, and, finally, to the arrangement of the motor mechanism in the phonographic apparatus. 16 claims.

1894.

139. "Improvements in telephone exchange systems." R. Callender. Dated January 2nd. Is directed particularly to improvements in that type of apparatus known in the art as automatic telephone exchange systems, in which the subscribers, through the agency of apparatus located at outlying stations and additional apparatus located at a central or main exchange, are enabled to automatically effect intercommunication with each other in any desired order. 56 claims.

3,072. "Improvement in arc lamps." J. E. Woolverton. Dated February 13th. Has for its object to provide simple and efficient means for positively feeding the carbons or electrodes of the lamp, and to permanently maintain the arc of the lamp in fixed relative position. 8 claims.

3,108. "Electric railways." P. W. Leffler and C. E. Corrigan. Dated February 13th. A magnetic field is extended along the entire line of travel; a non-rotating magnetic armature is carried by the car, for co-operation with said field; pole changing mechanism, operating according to the speed of the car, is applied to one of said magnetic members: the field is supplied with current from a central station or other distant source of electricity; the armature and certain other parts carried by the car are preferably supplied with current from a small storage battery on the car; and a combined regulating and reversing device is carried by the car and provided with reversing contacts, in the connections to the armature, operative by a single lever, for reversing the direction of travel. 18 claims.

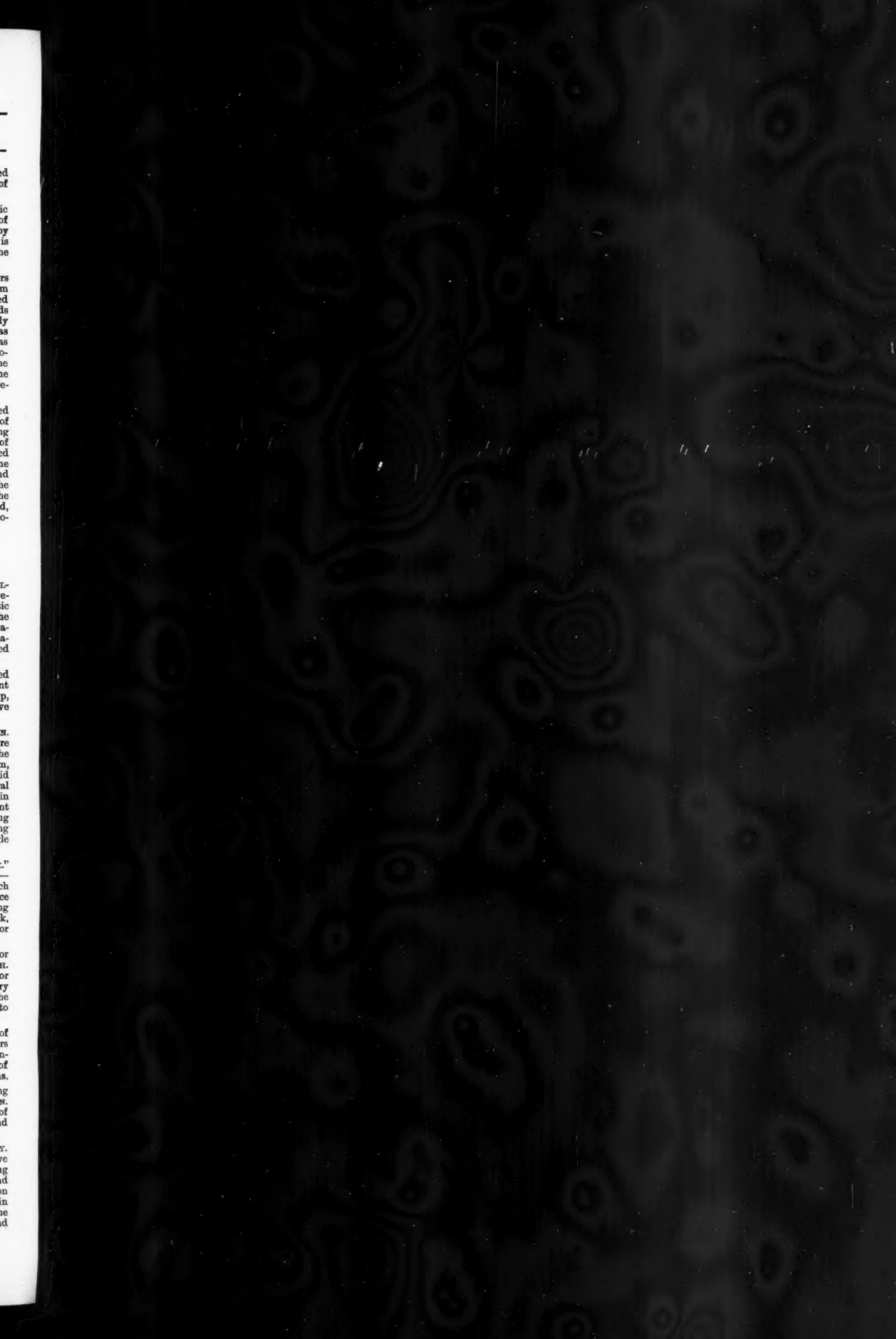
3,902. "A new method of applying electromotors to lathe work." A. Chamberlain and G. Hookham. Dated February 23rd. Claims:—1. Mounting an electromotor on the slide rest of a lathe, in such manner that an emery wheel or other grinding or polishing device carried on, and rotated by the motor spindle, may be traversed along the work in the lathe and applied to grind or polish the said work, substantially as described. 2. The electrically actuated grinding, or polishing arrangement, described as illustrated in the drawings.

4,091. "Appliances for the carbons of electric arc lamps for increasing the duration thereof." F. Jehl and M. von Hardtmuth. Dated February 26th. Consists essentially of a protecting socket or sleeve surrounding the upper carbon and formed of a refractory material, and of a protective guide or support placed free upon the point of the lower carbon and in some cases suitably connected to the socket or sleeve of the upper carbon. 3 claims.

4,244. "Improvements in and relating to the overhead system of electric tramways." A. Dickinson. Dated February 28th. Refers more particularly to the trolleys and trolley poles, by which the inventor is enabled to work this system, which obviates the necessity of span or pull over wires, with much more ease and certainty. 3 claims.

4,333. "Improvements in and relating to apparatus for supporting and suspending electric light and other like fittings." W. H. Johnson. Dated March 1st. Is specially adapted for sectional lighting of incandescent electric light lamps but is applicable for supporting and suspending other lamps and articles. 3 claims.

5,474. "Improvements in electric arc lamps." W. J. Davy. Dated March 15th. Relates to focussing lamps in which the positive and negative carbon holders are connected together by a cord passing over a pulley and in which the upper carbon holder tends to descend by gravity and thus at the same time to draw up the lower carbon holder so as to bring the two carbons into contact; and consists in an improved arrangement for striking and maintaining constant the arc consisting of a gravity friction grip device acting on the cord and regulated by series and shunt solenoids. 5 claims.



Fasten this in on a Slit so it will open out easily.

SPECIAL SUPPLEMENT.]

THE "ELECTRIC

LIST O

ELECTRIC LIGHT CENTRAL ST

ABERDEEN.—Corporation. L.T. three-wire system with accumulators. Three Willans & Robinson engines 80 I.H.P., two 1-H.P., four 90 nominal H.P. Babcock boilers. Underground mains, bare copper strip in concrete culvert. 10 10-ampère arc lamps used for street lighting. Private lighting equivalent to 7,400 8-C.P. lamps. Price per unit, 7d.; gas 3s. 5d. Gas coke used for boilers. Arc lamps run 4 in series across 220 volts. Cost of constructing station, £23,900. Resident Engineer, E. T. Ruthven Murray, Corporation Electric Light Station, Aberdeen.

ST. AUSTELL.—Veale & Co. L.T. system. 3 compound engines aggregating 160 H.P. Underground mains. 1 arc and 1,600 incandescent lamps for private lighting. Several motors are used for printing, grinding, stone-masons' work, &c. Engineer, J. M. Coon, Elm Cottage, St. Austell.

BATH.—Bath Electric Lighting Company. Thomson-Houston machines for street lighting. Brush Company alternators for private supply. Babcock boilers, Raworth and Browett-Lindley engines. 84 arcs for street lighting, 7 arcs and 7,880 8-C.P. incandescent for private lighting; capacity of station, 10,000 incandescent and 200 arcs. Callender underground mains. 1,100 lamps added during the past year. Station cost £40,000. 6d. per B.T.U.; gas 2s. 8d. per 1,000 feet. Coal and liquid fuel used for stoking. Manager and Engineer, G. F. Metzger, 7, Dorchester Street, Bath.

BEDFORD.—Corporation. High pressure alternating current. 3 Belliss engines, 3 Kapp alternators, 30 kw. each. 2 Babcock and Wilcox boilers, and a gas engine driving a 10 kw. Kapp alternator transformer. Sub-stations and distribution on 3-wire system. Capacity of station, 2,000 10-C.P. lamps, about 3,000 wired. Price per unit, 6d.; gas, 3s. 3d. Consulting Engineer, F. H. Medhurst.

BIRMINGHAM.—Birmingham Electric Supply Company, Limited. L.T. system. Willans engines, Lancashire boilers (1,400 H.P.), and Crompton dynamos. Underground mains, feeders consisting of copper strip in culvert, on Crompton system; distributing mains on Callender's solid system. No street lighting: 90 arcs and 9,400 16-C.P. lamps for private lighting. 2,300 16-C.P. lamps added during the past 12 months. Capacity of station, 25,000 8-C.P. lamps. Price per unit, 8d., with sliding scale; gas 2s. 10d. Engineer, J. C. Vaudrey, 14, Dale End, Birmingham.

BLACKPOOL.—Corporation. H.T. alternating (2,000 v.) for private supply. Series arcs for public lighting. Fowler engines, Lowrie-Hall alternators, Brush arc machines. 100 arcs and 10,000 8-C.P. lamps for private lighting, and 101 arc lamps for street. Price per unit, 6d.; gas, 2s. 4d. Station, with extensions, cost £50,000; mains, £7,900. Capacity of station, 14,000 8-C.P. lamps (8,000 lamps added during past year), and 165 arc lamps of 2,000 C.P. Engineer, John Hesketh.

BOLTON.—Corporation. H.T. alternating with sub-stations. L.T. network on a three-wire system. 3 Lancashire boilers and 3 engines of Messrs. J. & E. Woods; 3 Mordey alternators; H.T. concentric vulcanised rubber in iron pipes; L.T. Siemens triple core armoured cable. Price per unit, from 5½d. to 8d.; gas, 3s. 2d. Use of coke breeze contemplated. Estimated outlay, £21,000. About 3,500 8-C.P. connected. Engineer, J. H. Rider, Town Hall, Bolton.

BOURNEMOUTH.—Bournemouth and District Electric Supply Company. H.T. alternating current. Mordey-Victoria alternators and Brush engines, of 750 I.H.P., Babcock boilers 800 H.P. Mains, armoured cables drawn into cast-iron pipes. 17,473 8-C.P. incandescent lamps, wired for private supply. 4,500 lamps added during past year. Capacity of station, 12,500 8-C.P. lamps used simultaneously. Price per unit, 8d.; gas, 3s. 6d. Annual revenue per 8 C.P., about 8s. 6d. Engineer, H. M. Sayers, Verulam House, Yelverton Road, Bournemouth.

BRADFORD.—Corporation. Two-wire low tension system with batteries. 7 Siemens dynamos, Willans engines, and 5 Lanc. boilers. Siemens armoured cable (underground). 26,263 8-C.P. lamps connected for private lighting, 11,000 lamps added during past year. Station cost £36,884; mains £9,587. Price per unit, 5d. for light; power 4½d. Price of gas, 2s. 3d. Revenue per 8 C.P. lamp, 7s. 6d. Extension on three-wire system. Engineer-in-Chief, Sydney W. Baynes, Town Hall, Bradford.

BRAY (IRELAND).—A company. High-tension alternating system (1,000 volts), with two wire low-tension distribution from transformer sub-stations. Brush Falcon Company 120 H.P. engine; Davey-Paxman 40 H.P. loco. boiler; 2 Victor turbines 40 H.P.; 30 arc lamps, and 108 incandescent lamps of 25 C.P. for street lighting; private lighting equivalent to 846 8-C.P. Price per unit, 8d., or by contract. Present capacity of station in 8 C.P., 3,500. 562 lamps added during past year. Price of gas, 4s. 9d. Annual revenue per 8-C.P. lamp, 11s. 6d. Total cost of erecting station, £10,000. Engineer-in-Chief, G. Marshall Harris, Bray Mills, Ireland.

BRIDLINGTON.—Municipal Authority. Thomson-Houston arc-lighter. Motive power hired from sawmill. 18 arcs of 1,200 C.P. each Lamps run during summer season. Engineer, R. Railton Brown.*

BRIGHTON.—Corporation. L.T. two-wire system. Goolden and L. Clark and Muirhead dynamos, Willans engines, total I.H.P. 2,000. 6 Lancashire boilers. Underground armoured cables. 40 arcs used for street lighting, 38,000 8-C.P. incandescent for private lighting. 19,000 added during past 12 months. Price per unit, 7d., and 3½d. after two hours' daily use; gas 2s. 11d.; coal, 20s. per ton. Cost of constructing and equipping Central Station, £40,000. Cost of mains, £38,670. Engineer, Arthur Wright, Electricity Works, North Road.

BRIGHTON.—Brighton and Hove Electric Light Company. The Electricity Supply business has now been transferred to the Corporation of Brighton, under terms of agreement for the purchase of the goodwill of the business.

BRISTOL.—Corporation. H.T. alternating current system, with low tension distributing network. Arc lighting by continuous current. Lanc. boilers, 8 Willans engines, Siemens dynamos and alternators. Underground mains, Siemens concentric cables, triple armoured, single armoured for arcs. 106 arcs for street ligthing, 9,700 8-C.P. incandescent and 18 arc lamps for private use. Capacity of station, 26,900 8-C.P. Price per unit, 6d.; gas, 2s. 10d. Cost of station, £100,000. Engineer, H. Faraday Proctor, Electric

COWPEN QUAY.—Sanderson & Co. Brush arc lamps in series. Babcock boiler, Chandler engine. Overhead wires with fluid insulation. 19 arcs of 2,000 C.P., used for harbour lighting. Engineer, R. S. Mylton. No further information.*

DERBY.—Corporation. Alternating current sub-station system with ring main secondary for private supply, constant current arc for street lighting. 3 Lancashire boilers with Galloway tubes. Siemens alternators and arc lighters coupled direct to Browett & Lindley engines. Underground armoured feeder mains, vulcanised mains for distributing. 7,000 8-C.P. lamps for private lighting, 77 arcs for streets. Capacity of station, 9,300 lamps of 8 C.P., not including an extension engine which will supply 5,800 lamps. Price per unit, 6d.; 3d. for power, cooking, &c.; gas, 2s. 8d. Engineer-in-Chief, J. E. Stewart.

DEWSBURY.—Corporation. Low-pressure three-wire, with accumulators. Lancashire boilers, Willans engines, total I.H.P. about 500; feeders, concentric armoured, distributing non-concentric, armoured. Capacity of station 5,000 8-C.P. lamps. Electrical Engineer, J. B. Mitchell, Bradford Road, Dewsbury.

DOVER.—A company. High-pressure alternating system, Babcock and Wilcox boilers. Vertical compound engines 600 H.P., Mordey alternators. High-pressure cables are Silvertown concentric, low-pressure B.I.W. concentric. 21 arcs will be used for street lighting. Nearly 2,000 8-C.P. applied for private lighting. Capacity of station 10,000 C.P. 8d. per unit; gas, 2s. 6d. Cost of constructing and equipping station, £35,000. Engineer-in-Chief, A. J. Lawson, 49, Queen Victoria Street, E.C.

DUBLIN.—Corporation. High tension alternating (2,000 v.), with house transformers, for private supply; 3,000 v. arc circuits for public lighting. 4 Babcock boilers, 3 compound engines of 350 H.P. each, and 1 of 100 H.P. for private supply; 3 compound engines of 60 H.P. each, for public lighting. Lowrie-Hall alternators, Brush arc machines, Silvertown cable in underground pipes. 81 500-watt arc lamps for streets; 21 arcs, 13,500 8-C.P. incandescent, for houses. Gas, 3s. 4d. The station cost £31,000. Engineer, Mark Ruddle, Central Station, Dublin.*

DUNDEE.—Corporation. L.T. 3-wire system with accumulators. 3 Lancashire boilers, 6 Willans engines, and 6 continuous current dynamos by Siemens. A battery of accumulators with an output of 350 ampères for one hour. 30 arcs and 12,000 incandescents connected for private supply. 5d. per unit.; gas, 3s. 4d., less 5 per cent. Cost of feeders and mains (exclusive of service mains) £6,590. Cost of constructing and equipping central station, £30,000. Engineer, W. H. Brownlee, 1, Blackness Crescent, Dundee.

EASTBOURNE.—Eastbourne Electric Light Company. H.T., alternating system, with house transformers; series system for arc lighting Fowler's engines and boilers; total engine H.P. 400. Lowrie-Parker alternators. Underground main; insulated cables drawn into cast-iron pipes. 26 arc lamps, used for street lighting; 8,400 8-C.P. lamps for private lighting. Price per unit, 9d.; gas, 3s. 2d. Engineer, H. W. Wilkinson, Central Station, Eastbourne.*

EXETER.—Exeter Electric Light Company. H.T. alternating and H.T. series arc. Two compound horizontal, non-condensing engines, 120 H.P. each, and 1 80-H.P. by Fowler, and two Westinghouse triple expansion engines of 25 H.P. 3 Babcock boilers, 150-H.P. each. Underground mains, Fowler-Waring concentric cable. 32 arcs and 6,000 8-C.P. for private lighting. Capacity of station, 6,600 8-C.P, and 60 arc lamps; 1,000 lamps added during the past year. Price per unit. 6d. with rebate; price of gas, 3s. 1d. Cost of station, £11,000. Cost of mains, £7,700. Engineer, H. D. Munro, Rockfield Works, Exeter.

FAREHAM.—Fareham Electric Light Company. Thomson-Houston system. Ransomes, Sims & Co. compound engines. Overhead and underground mains. 20 arcs and 90 incandescent lamps for street lighting, and 320 16-C.P. incandescent lamps for private lighting. Price to consumers 1s. per C.P. per annum and 8d. per unit; gas 3s. 9d. Station, with mains, cost originally £5,000. Negotiations pending for transference of business to the local authorities.*

GALWAY.—Galway Electric Light Company. Low tension system. Crompton and Statter dynamos; 2 Hercules turbines. 7 arcs and 4 incandescents for docks; 1,700 8-C.P. incandescent for private lighting. Price per unit, 5d.; for power, 3d.; gas, 5s. 9d. Engineer, J. E. Pearce.

GLASGOW.—Corporation. L.T. three-wire system, with accumulators for private lighting. 3,000 v. arc machines for street lighting. Latimer Clark-Muirhead dynamos and Willans engines, 1,900 I.H.P. 6 boilers of 300 H.P. each, by Lindsay, Burnett & Co. Brush machines and Easton-Anderson engines for street lighting. Arc light mains are of rubber insulation drawn into iron pipes. L.T. network copper strip in C.I. culverts. About 102 arc lamps have been erected in the streets. 30,000 8-C.P. incandescent lamps for private lighting. Capacity of station, 30,500 8-C.P. lamps. Price per unit, 6d.; gas, 2s. 6d. Cost of system including the taking over of Mavor and Coulson stations up to May, 1893, £60,000. Engineer-in-Chief, W. Arnot.

GLASGOW.—Kelvinside Electric Light Co. L.T. three-wire system, with accumulators. 2 Babcock boilers, 150 H.P., 2 Willans engines, 150 H.P., and Goolden dynamos direct coupled. Underground mains, Callender's covered and armoured type. 4,000 8-C.P. connected for private lighting. Capacity of station, 5,000 8-C.P. burning at one time. Price per unit, 8d.; gas, 2s. 6d. Engineer-in-chief, W. Elsdon Dew.

HANLEY.—Corporation. H.T. alternating current with transformers at sub-stations. 3 boilers, 2 com. vertical engines, 200 H.P. each, 2 of 100 H.P. each, 2 engines and dynamos (continuous current) for street lighting. 80 arc lamps for street lighting. 7,200 8-C.P. and 25 alternating arcs used for private lighting. Underground mains, primary concentric in cast-iron pipes. Low pressure in cast-iron trough filled up with bitumen. The capacity of the station is 10,000 lamps of 8 C.P. Price per unit, 6d.; gas costs 2s. 6d. Extensions projected. Engineer in charge, G. H. Cottam. Corporation Electrical Engineer.

HASTINGS.—Hastings and St. Leonards Electric Light Company.

LARNE (CO. ANTRIM).—J. E. H. Gord
High tension alternating system with sub-st
transformers. 2 horizontal engines 50 I.H.P.
nators (2,000 v.). 2 Cornish boilers. High te
concentric) are placed underground; part of
supplied from transformers on poles. Streets
incandescents. About 400 8-C.P. lamps for
station about 1,500 8-C.P. Price per unit, 6d
is done on a contract of £1 per 16 C.P. l
Resident engineer. Archer Turner.

LEAMINGTON.—Midland Electric Light
2-wire system. Robey engines and Chamb
This information is not up to date.

LEEDS.—Yorkshire House-to-House Com
nating with house transformers. 6 Lanc. b
I.H.P., 1,800), Lowrie-Hall alternators. Un
cables in cast-iron pipes. Private supply
Price per unit, 6d. to 7d. less discount;
£66,000. Foregoing figures include extens
engineer, H. Dickinson.

LIVERPOOL.—Liverpool Electric Supply
direct, partly two-wire and partly three-wire.
(3,800 I.H.P.). Lanc. boilers, 5,700 I.H.P. Sie
Underground mains on Callender system.
28,513 16-C.P. lamps, 6,000 16-C.P. added du
of stations, 32,000 16-C.P. lamps. Price per u
16 C.P. lamp, 22s. for 1893. Engineer-in-C
Highfield Street, Liverpool.

LONDONDERRY.—Corporation. H.T. co
Lancashire boilers of 400 H.P., 3 compound c
6 Siemens dynamos, constant current 10 am
engine. Underground mains, armoured ca
present, there being 170 arc lamps. Cost
central station, £20,000. Engineer, H. W.
Londonderry.

LONDON DISTRICTS:—

BELGRAVIA and PIMLICO.—Westm
poration, Eccleston Place Station. L.T
and distribution in two parallels of 100 v
Paxman engines. Davey-Paxman "Ec
of same kind. Crompton and Siemens d
bare copper in culverts, and insulated
Engineer-in-Chief, Prof. A. B. W. Kenned

MAYFAIR.—Westminster Electric S
Street Station. Same system as at Eccl
Paxman and Fraser boilers. Crompton
Same system of mains as other stations.
W. Kennedy.

WESTMINSTER.—Westminster Ele
Millbank Street station. Same system a
this company. Willans engines, Babc
nections for the three stations of this com
lamps, about 32,000 lamps have been add
three stations 5,200. Engineer-in-Chief, H

CHELSEA.—Chelsea Electricity Su
System, generation of current at 200 volts a
of 100 v. each. Batteries in parallel with 20
Siemens dynamos, Willans engines, and
mains on Callender-Webber system. 50
lamps for private lighting, 8,000 lamps
Capacity of station, 50,000 8-C.P. lamps. P
gas 3s. 1d. Revenue per 8 C.P. lam
Frank King, 4, Great Winchester Street, E
Still, Draycott Place, Chelsea.

CITY OF LONDON.—City of Londo
and District of St. Saviours. H.T. altern
sub-stations, and L.T. three-wire distril
stations, nearly completed, in which are
aggregating 9,225 H.P. Mordey-Victoria,
and arc machines. Underground cables o
505 arcs for streets, and about 130,000 8-C.P
private lighting. 74,000 8-C.P. added duri
station, 150,000 8-C.P. lamps. Twenty-t
been constructed. Price per unit, 8d., an
ing, and cooking. Engineer-in-Chief,

CRYSTAL PALACE.—Crystal Palace
Company. High tension system with mo
Hornsby engines and boilers (5 of each
in sub-stations. Electrical plant by the
pany, Limited. 6,500 incandescent an
lighting. Capacity of stations, 28,000 8-
8d; gas, 2s. 8d. Total outlay, £70,000. R

EALING.—Local Board. High pre
for private lighting, high pressure co
Siemens dynamos and Browett & Lindley
Fryer refuse destructors are used in co
plant. Horse-power of station about 5
means of transformer sub-stations. 7
Capacity of station, 5,000 8-C.P. lamps.

HAMPSTEAD.—The Vestry. High
transformer sub-stations, distribution on th
arc lighting on continuous current seri
boilers, Willans engines of 450 B.H.P.
tinuous current machines. High press
cased, armoured, low pressure network
mains. 22 arcs for street lighting, 2,000 8-C
Capacity of station, 11,970. 6d. per unit w
Cost of constructing and equipping cen
Resident engineer, R. A. Chattock, Ele
Road, Finchley Road, N.W.

NOTTING HILL and part of ST. MA
Hill Electric Lighting Company. L.T. dir
and Wilcox boilers, Willans engines, tw

LIST OF

STATIONS OF GREAT BRITAIN.

.—J. E. H. Gordon & Co. (in liquidation).
system with sub-station transformers and street
tal engines 50 I.H.P. each. 2 25-k.w. Mordey alter-
sh boilers. High tension mains (British insulated
nderground; part of low tension network overhead
ers on poles. Streets lighted by 11 arc lamps and 68
0 8-C.P. lamps for house lighting. Capacity of
. Price per unit, 6d., though much of the lighting
of £1 per 16 C.P. lamp per annum; gas, 4s. 7d.
er Turner.

nd Electric Light Company. Low tension
engines and Chamberlain & Hookham dynamos.
p to date.

use-to-House Company. High tension alter-
formers. 6 Lanc. boilers, 6 Fowler engines (total
ll alternators. Underground mains, Silvertown
s. Private supply consists of about 15,822 8-C.P.
7d. less discount; gas, 2s. 2d. Cost of station,
ures include extensions in progress. Resident

ol Electric Supply Company. Low tension
d partly three-wire. Lanc. boilers, Willans engines
lers, 5,700 I.H.P. Siemens and Crompton dynamos.
Callender system. Private lighting equivalent to
0 16-C.P. added during the past year. Capacity
lamps. Price per unit, 7½d.; gas 3s. Revenue per
893. Engineer-in-Chief, A. Bromley Holmes, 15,
ol.

poration. H.T. continuous current system.
H.P., 3 compound condensing vertical engines and
stant current 10 ampères at 3,000 volts, 2 on each
ains, armoured cables. Street lighting only at
arc lamps. Cost of constructing and equipping
Engineer, H. W. Blake, 35, Shipquay Street,

MLICO.—Westminster Electric Supply Cor-
Place Station. L.T. system, generated at 200 v.
vo parallels of 100 volts each. Willans and Davey-
Davey-Paxman "Economic" boilers, and Fraser
pton and Siemens dynamos. Underground mains,
verts, and insulated cable in Callender conduit.
rof. A. B. W. Kennedy.

inster Electric Supply Corporation, Davies
e system as at Eccleston Place. Willans engines
boilers. Crompton and Elwell-Parker dynamos.
is as other stations. Engineer-in-Chief, Prof. A. B.

Westminster Electric Supply Corporation,
on. Same system as other stations belonging to
lans engines, Babcock boilers. Total lamp con-
e stations of this company amount to 163,000 32-watt
mps have been added this year. Total I.H.P. of
Engineer-in-Chief, Prof. A. B. W. Kennedy.

a Electricity Supply Company, Limited.
current at 200 volts and distribution in two parallels
es in parallel with 200-volt dynamos. Crompton and
illans engines, and Babcock boilers. Underground
Webber system. 50 arcs and 46,000 incandescent
hting, 8,000 lamps added during the past year.
0,000 8-C.P. lamps. Price per unit, 8d. with rebates;
e per 8 C.P. lamp, 8s. 6d. Engineer-in-Chief,
Winchester Street, E.C. Resident engineer, Percy
Chelsea.

—City of London Electric Light Company
viours. H.T. alternating system with transformer
T. three-wire distributing network. Two central
leted, in which are 24 vertical compound engines,
P. Mordey-Victoria, Thomson-Houston alternating
nderground cables on Callender and other systems.
d about 130,000 8-C.P. lamps and 155 arc lamps, for
00 8-C.P. added during the past year. Capacity of
. lamps. Twenty-two transformer stations have
rice per unit, 8d., and 4d. per unit for power, heat-
ngineer-in-Chief,

.—Crystal Palace District Electric Supply
ion system with motor generators in sub-stations.
1 boilers (5 of each), 7 batteries of accumulators
ctrical plant by the Electrical Construction Com-
0 incandescent and 15 arcs used for private
f stations, 28,000 8-C.P. lamps. Price per unit,
l outlay, £70,000. Resident engineer, P. J. Rea.

oard. High pressure alternating current
high pressure continuous for public lighting.
t Browett & Lindley engines, Lancashire boilers.
tors are used in conjunction with steam raising
of station about 500. Distribution is done by
er sub-stations. 70 arc lamps in the streets.
000 8-C.P. lamps.

e Vestry. High pressure alternating, with
ons, distribution on three-wire low pressure. Public
inuous current series system. 4 200-H.P. Lanc.
nes of 450 B.H.P. Siemens alternators and con-
chines. High pressure concentric feeders, lead
y pressure network, Siemens triple concentric
eet lighting, 2,000 8-C.P. lamps for private lighting.
,970. 6d. per unit with sliding scale; gas, 2s. 10d.
and equipping central station, £27,144 approx.
. A. Chattock, Electricity Department, Lithos
N.W.

l part of ST. MARY ABBOTTS.—Notting
Company. L.T. direct current system. Babcock

LYNTON.—Hans H. Benn. H.T. alternating current system. Water power; C. L. Hett's turbine and Mordey alternator. 37 32-C.P. lamps for street lighting, 1,200 8-C.P. incandescents in use for private lighting.

MANCHESTER.—Corporation. L.T. 5-wire system. 7 Lancashire boilers, 6 large vertical com. engines, 400 H.P. each, 6 small vertical com. engines, 100 H.P. Dynamos by Electric Construction Corporation and Mather & Platt. Underground mains, concrete culverts with bare copper mains, iron pipes with insulated cables. No street lighting. 264 arc lamps, 44,294 8-C.P. lamps, and motors. Capacity of station, 60,000 lamps of 8-C.P. Price per unit varies from 8d. to 2¾d., according to number of hours burning. Cost of constructing and equipping central station, including land, £83,846. Cost of mains and laying, £37,592. Engineer-in-chief, Charles Henry Wordingham, Corporation Works, Dickinson Street, Manchester.

MORECAMBE.—Morecambe Electric Light and Power Company, Limited. L.T. two-wire system. Gas engines; 3 Stockport 40 I.H.P., 1 Crossley 60 I.H.P., and 1 Crossley of 150 I.H.P., these are supplied by Dowson gas apparatus. Arc lamps and incandescent lamps used in private supply equivalent to 3,200 8-C.P. 1,000 incandescents have been added during the past year. Capacity of station is about 3,600 8-C.P. Price per unit, 7d.; gas 3s. 8d. per 1,000 feet. Cost of plant about £10,000. Engineers, Messrs. Andrews & Preece, Borough Mills, Bradford.

NELSON.—Corporation. L.T. two-wire system with accumulators. 2 Willans engines of 80 and 135 I.H.P. Lancashire boilers. Mains are laid underground in cast-iron conduits. 4 arc lamps for street lighting, and about 2,000 16-C.P. incandescents for private lighting. Capacity of station 5,000 16-C.P. lamps. Price per unit, 5d., with discount for cash.; gas 2s. 9d. per 1,000 feet. Waste heat from gas retort furnaces used for boilers. Cost of constructing and equipping central station, £9,500; mains, £5,000. Engineer, John Foster, Engineer's Office, Gas Works, Nelson.

NEWCASTLE.—Newcastle and District Electric Lighting Company, Limited. H.T. alternating current system. 5 Lancashire boilers and Parsons turbo-electric generators, 900-unit plant. Underground mains. 9 arc lamps for street lighting, 80 arcs and 21,000 10-C.P. incandescents. 3,000 lamps added during past 12 months. Price per unit, 6d., less discount, varying from 5 to 25 per cent.; gas, 1s. 10d. Total cost of constructing and equipping central station, £47,000. Engineer, W. D. Hunter, 38, Granger Street West, Newcastle.

NEWCASTLE.—Newcastle Electric Supply Company. H.T. alternating current with transformers. Lancashire boilers, horizontal compound engines, 1,200 H.P., underground concentric cables. 13 arcs used for street lighting. About 21,000 30-watt lamps used for private lighting Price per unit, 4½d. with discounts; gas 1s. 10d., less 10 per cent. Engineer R. C. Jackson, Pandon Dene, Newcastle-on-Tyne.

NORTHAMPTON.—Northampton Electric Light and Power Company, Limited. L.T. direct current. 3 Daniel Adamson Lancashire boilers, 3 Scott & Hodgson's vertical compound engines, each of 120 I.H.P., and Crompton dynamos. Crompton system of underground mains. 30 arcs and 5,100 incandescent used for private lighting. Capacity of station, 7,600. Price per unit, 8d., less 5 per cent.; gas 2s. 6d. per 1,000. Revenue per 8-C.P. lamp, 6s. 7d. Cost of constructing and equipping central station, £30,000. Engineer, W. G. Heeman, Electric Light Station, Northampton.

NORWICH.—Norwich Electricity Company. L.T. continuous current three-wire system. 3 Willans engines, 100 H.P. each. 2 Babcock-Wilcox boilers, 140 H.P. each. Underground mains, bare copper, about 2,000 yards laid in culverts, the rest in earthenware pipes on Scott system. Maximum output of station, 1,100 ampères. Capacity of station in lamps, 3,000 16-C.P. Price per unit, 8d. for a period of day between an hour after sunset and 8 p.m., rest of day 4d. per unit.* Engineer, F. M. Long, Duke Street, Norwich

NOTTINGHAM. — Corporation. L.T. 3-wire system. 3 Willans engines of 80 I.H.P., and 3 of 134 I.H.P. Lancashire boilers. Underground mains on Callender-Webber system. 27 arcs and 4,000 8-C.P. used for private lighting. Capacity of station, 10,000 8-C.P. lamps. 6d. per unit, price of gas, 2s. 4d. Cost of station, £45,000, feeders and distributors, £8,411. Engineer, H. Talbot, 19, Addison Villas, Nottingham.

OGMORE VALLEY.—A company. Low pressure system. Information not up to date.

OLDHAM.—Corporation. Low pressure 2-wire. 2 Lancashire boilers of 350 H.P. each. Willans engines, 3 of 100 H.P. each, and 2 of 60 H.P. each. Bare copper strip in culverts where possible, elsewhere Siemens cables in cast-iron pipes. 14 arcs for street lighting, 4,832 8-C.P. lamps for private lighting. Capacity of station, 6,000. 6d. per unit; gas, 2s. 4d. Cost of constructing and equipping central station, £18,895, which includes land. Consulting Engineer, Professor A. B. W. Kennedy.

OXFORD.—Oxford Electric Light Company.—H.T. continuous current with motor-generator transformers. Three triple expansion engines, surface condensing, marine type of 200 H.P. each, 3 loco. boilers (Mc Laren) of 400 H.P. each; dynamos by Electric Construction Corporation. Underground mains, H.T., Silvertown, L.T., Callender's lead covered. Sixteen arcs used for street lighting, 6 arcs and 10,562 8-C.P. lamps for private lighting, 3,891 8-C.P. added during the past year. Capacity of station, 15,000 8-C.P. Price per unit, 8d., with 5 per cent. discount on accounts paid within the month; gas 3s. 2d. per 1,000. Annual revenue per 8-C.P. lamp, 10s. Engineer, J. Hardie McLean, 45, Broad Street, Oxford.

PORTSMOUTH.—Corporation. H.T. alternating (2,000 volts). Lancashire boilers. 2 300-H.P. horizontal compound engines, by Yates & Thom, are combined with 2 Ferranti alternators; a Parson turbine drives an alternator. Rectifiers are used for the street lamps. Underground mains on Johnstone's patent subway system; other mains by Glovers.*

PRESCOT.—British Insulated Wire Company. H.T. alternating current system. 2 Lanc. boilers. 2 Mordey and 2 Ferranti alternators; 2 Raworth and 2 Browett & Lindley engines. Underground mains on B.I.W. system. 15 2,000-C.P. arcs and 96 16-C.P. incandescent for street lighting, about 1,300 8-C.P. for private lighting. Capacity of station, 2,600. Price per unit 6d. with discount [illegible] 8-C.P.

TAUNTON.—Corporation. H.T., alternating current system (Thomson-Houston) for private lighting, and Thomson-Houston series arc lamps. Babcock and Davey-Paxman boilers. 2 Willans engines, indicating 120 H.P. each; 2 Ruston, Proctor & Co.'s, indicating 75 H.P.; one Bumsted-Chandler, indicating 50 H.P.; 2 Thomson-Houston alternators of 70 units each; and one Thomson-Houston of 25 units. 4 T.H. arc lighters of 30 lights each, and one 10½-unit Elwell-Parker dynamo. There are 36 public and 40 private arc lamps and 2,200 8-C.P. incandescent lamps installed. Mains are at present overhead, but will shortly be placed underground. Price per unit, 6d.; gas, 3s. 9d. Price of coal is 16s. 6d. Managing Electric Engineer, Harold W. Couzens, St. James Street, Taunton.*

THETFORD.—Thetford Electric Light Company. L.T. system. 2 50-H.P. boilers, 1 20-H.P. engine, 1 10-H.P. engine. Lawrence-Scott dynamos. Overhead and underground mains. 70 arc lamps and 600 8-C.P. lamps. Capacity of station 1,800 8-C.P. lamps. Price per unit, 6d. and 7d., price of gas, 5s. Total cost of constructing and equipping central station, £3,000. Engineer, R. Carter.

WEYBRIDGE.—Electric Light Company. Thomson Houston system. Two 75-H.P. compound engines, and one 100-H.P. boiler. 500 16-C.P. lamps in use. Overhead wires.*

WHITEHAVEN.—Corporation. L.T. two-wire system for street lighting, and low tension three-wire for private lighting. Two Lancashire boilers, total H.P., 500. Four Willans engines and Crompton dynamos, total H.P., 240. Underground mains by Siemens. The streets and harbour lighted by 500 incandescent lamps of 8 to 64 C.P. 5 arcs and 1,400 16-C.P. incandescents for private lighting. Capacity of station, 2,300 16-C.P. 5d. per unit; gas 3s. 6d. per 1,000 feet. Works not yet completed. Consulting Engineer, Dr. John Hopkinson, 5, Victoria Street.

WICKWAR.—A company. Low tension, two-wire system, with accumulators. 1 Davey-Paxman 60 I.H.P., Adlam's 15 I.H.P., and one over-shot water-wheel, 20-H.P. Elwell-Parker dynamos. Overhead wires. 20 incandescent lamps of 32-C.P. for public supply, 330 incandescent lamps, almost all used by the owners of the installation. This installation is really a private one, but the owners have run a circuit by special request of the inhabitants to light the principal thoroughfare. Engineer, F. G. Ansell, Wickwar, Glos.

WOKING.—A company. H.T., alternating current system. No other particulars obtainable.

WOOLWICH.—Woolwich District Electric Light Company, Limited. H.T. alternating transformer system. Chandler high-speed engines, 250-H.P. Underground mains in cast-iron pipes. 2,500 35-watt incandescent lamps and 14 arcs used for private lighting. Capacity of station, 5,000 lamps. Price per unit, 6d., gas 2s. 5d. Cost of station £9,000 approx. Engineer, G. E. B. Pritchett, 31, Soho Square, W.

WORCESTER.—Corporation. High pressure alternating with transformer sub-stations. 3 Brush compound vertical engines, each of 286-H.P. 2 54-in. turbines, each of 161-B.H.P. 1 48-in. of 123-B.H.P. 1 30-in. of 47-H.P. 4 Babcock and Wilcox water-tube boilers, each 125-I.H.P. Brook's oil mains. Concentric paper insulation mains for high pressure, and Callender's concentric for low pressure. 27 arc lamps for street lighting; 4 arc lamps and 4,000 incandescent for private lighting. Capacity of station, 11,000 8-C.P. lamps. 5d. per unit for lighting, 3d. for power; gas, 3s. 7d., less discount. Cost of constructing and equipping central station, including mains, £42,000. Borough Engineer, Thomas Caink.

GREAT YARMOUTH.—Corporation. High pressure alternating current. Babcock boilers, 400-H.P., and Willans engines, armoured cables. 60 arcs for lighting streets and Fish Wharf. Works not sufficiently advanced to take on private lighting. Capacity of station in 8-C.P., 4,500. 6d. per unit; gas, 3s. 2d. and 4s. 6d. Cost of constructing and equipping central station, £16,500. Consulting Engineer, W. H. Preece.

STATIONS NOT YET RUNNING.

ACCRINGTON.—Corporation have received sanction for borrowing powers to the extent of £10,000, and have purchased a site for the central station.

BELFAST.— The Corporation electric light station in course of erection. Gas engines are to be employed. Consulting Engineer, Prof. Kennedy.

BLACKBURN.—Low pressure continuous current. Works in course of construction.

CHELTENHAM.—Corporation. High pressure alternating. Station in course of construction. Price will vary from 6d. to 3d. per unit according to quantity consumed.

CHESTER.— Low pressure 3-wire system. Local Government Board Enquiry has been held.

COVENTRY.—Corporation. High-pressure alternating with low pressure distributing mains. 2 Lancashire boilers, 2 horizontal compound engines of 200 I.H.P. and 100 I.H.P. respectively; Hall alternators; concentric mains. 6d. per unit; gas, 2s. 7d. Station estimated to cost £20,000. R. Hammond, Consulting Engineer. Station will be completed early next year.

14,000 8-C.P. lamps (8,000 lamps added during past year), and 166 arc lamps of 2,000 C.P. Engineer, John Hesketh.

BOLTON.—Corporation. H.T. alternating with sub-stations. L.T. network on a three-wire system. 3 Lancashire boilers and 3 engines of Messrs. J. & E. Woods; 3 Mordey alternators; H.T. concentric vulcanised rubber in iron pipes; L.T. Siemens triple core armoured cable. Price per unit, from 5½d. to 8d.; gas, 3s. 2d. Use of coke breeze contemplated. Estimated outlay, £21,000. About 3,500 8-C.P. connected. Engineer, J. H. Rider, Town Hall, Bolton.

BOURNEMOUTH.—Bournemouth and District Electric Supply Company. H.T. alternating current. Mordey-Victoria alternators and Brush engines, of 750 I.H.P., Babcock boilers 800 H.P. Mains, armoured cables drawn into cast-iron pipes. 17,473 8-C.P. incandescent lamps, wired for private supply. 4,500 lamps added during past year. Capacity of station, 12,500 8-C.P. lamps used simultaneously. Price per unit, 8d.; gas, 3s. 6d. Annual revenue per 8 C.P., about 8s. 6d. Engineer, H. M. Sayers, Verulam House, Yelverton Road, Bournemouth.

BRADFORD.—Corporation. Two-wire low tension system with batteries. 7 Siemens dynamos, Willans engines, and 5 Lanc. boilers. Siemens armoured cable (underground). 26,263 8-C.P. lamps connected for private lighting, 11,000 lamps added during past year. Station cost £36,884; mains £9,587. Price per unit, 5d. for light; power 4½d. Price of gas, 2s. 3d. Revenue per 8 C.P. lamp, 7s. 6d. Extension on three-wire system. Engineer-in-Chief, Sydney W. Baynes, Town Hall, Bradford.

BRAY (IRELAND).—A company. High-tension alternating system (1,000 volts), with two wire low-tension distribution from transformer sub-stations. Brush Falcon Company 120 H.P. engine; Davey-Paxman 40 H.P. loco. boiler; 2 Victor turbines 40 H.P.; 30 arc lamps, and 108 incandescent lamps of 25 C.P. for street lighting; private lighting equivalent to 846 8-C.P. Price per unit, 8d., or by contract. Present capacity of station in 8 C.P., 3,500. 562 lamps added during past year. Price of gas, 4s. 9d. Annual revenue per 8-C.P. lamp, 11s. 6d. Total cost of erecting station, £10,000. Engineer-in-Chief, G. Marshall Harris, Bray Mills, Ireland.

BRIDLINGTON.—Municipal Authority. Thomson-Houston arc-lighter. Motive power hired from sawmill. 18 arcs of 1,200 C.P. each Lamps run during summer season. Engineer, R. Railton Brown.*

BRIGHTON.—Corporation. L.T. two-wire system. Goolden and L. Clark and Muirhead dynamos, Willans engines, total I.H.P. 2,000. 6 Lancashire boilers. Underground armoured cables. 40 arcs used for street lighting, 38,000 8-C.P. incandescent for private lighting. 19,000 added during past 12 months. Price per unit, 7d., and 3½d. after two hours' daily use; gas 2s. 11d.; coal, 20s. per ton. Cost of constructing and equipping Central Station, £40,000. Cost of mains, £38,670. Engineer, Arthur Wright, Electricity Works, North Road.

BRIGHTON.—Brighton and Hove Electric Light Company. The Electricity Supply business has now been transferred to the Corporation of Brighton, under terms of agreement for the purchase of the goodwill of the business.

BRISTOL.—Corporation. H.T. alternating current system, with low tension distributing network. Arc lighting by continuous current. Lanc. boilers, 8 Willans engines, Siemens dynamos and alternators. Underground mains, Siemens concentric cables, triple armoured, single armoured for arcs. 106 arcs for street ligthing, 9,700 8-C.P. incandescent and 18 arc lamps for private use. Capacity of station, 26,900 8-C.P. Price per unit, 6d.; gas, 2s.'10d. Cost of station, £100,000. Engineer, H. Faraday Proctor, Electric Lighting Station, Temple Back, Bristol.

BUCKINGHAM.—Buckingham Electric Light Company. L.T. system with accumulators. 20 H.P. by water, 20 H.P. by steam. Elwell-Parker dynamos. Overhead wires. About 3,000 16-C.P. incandescents used for private lighting. Station cost £1,200. Engineers, Rogers & Son.*

BURNLEY.—Corporation. Low tension, 3-wire, with accumulators. 2 horizontal compound condensing engines, 180 I.H.P. Electric Construction Corporation. Callender's steel armoured cable. Private lighting equivalent to 5,500 8-C.P. Capacity of station, 6,000. Cost of constructing and equipping central station, £20,000. Electrical Engineer, F. Thursfield, Electric Lighting Station, Burnley.

BURTON-UPON-TRENT.—Corporation. High tension alternating system. 3 Lancashire boilers. 3 horizontal compound engines of 106 Brake H.P. each. 3 Hall alternators. 2 arcs, 3,600 8-C.P. equivalents for private lighting. Capacity of station, 4,000 8-C.P. 6d. per unit; gas, 3s. Refuse used from gas-works for fuel. Cost of constructing and equipping central station, £25,000. Electrical Engineer, F. L. Ramsden, Gas and Electric Light Works, Burton-on-Trent.

CAMBRIDGE.—Cambridge Electric Light Company. H.T. alternating system (2,000 v.). 2 Lancashire boilers, 3 Parsons steam turbo-alternators. Underground mains, vulcanised rubber cables placed in iron pipes. About 3,000 10-C.P. incandescent lamps are connected. Present capacity (1893 actual) of station 300 units. It is expected that the ultimate capacity of the station will be 30,000 10-C.P. lamps. Manager and Engineer, J. H. Barker.*

CARDIFF.—Corporation. High tension alternating with transformers in street boxes. Compound and triple expansion engines, 2 of 75 H.P., 2 of 300 H.P. each. 3 300-H.P. Economic boilers. 48 arcs for street lighting. High tension cable, concentric (Silvertown). Price per unit, 6d., gas, 2s. 6d to 3s. Cost of constructing and equipping central station has not exceeded £32,500. Ferranti rectifiers are employed. Consulting engineer, W. H. Massey.

CHAGFORD.—G. H. Reed. H.T. alternating system with Hedgehog transformers. High breast water wheels, 50 H.P. Siemens dynamos. Underground mains, lead covered, paraffin paper insulation. 550 8-C.P. for private lighting, 14 32-C.P. for outdoor lighting. A charge of 10s. per 8 C.P. per annum is made; gas 5s. 10d. Station cost £2,000. Engineer, George Reed, The Factory, Chagford.

CHATHAM.—Chatham, Rochester, and District Electric Lighting Company. H.T. alternating system with house transformers. 3 Babcock and Willcox boilers, 1 Robey and 2 Marshall's engines, 2 Ferranti dynamos, and 2 Brush arc machines. Capacity of station, 8,600 8-C.P. lamps. Managing Director, H. Hurrell, Fair View, New Brompton, Kent.*

CHELMSFORD.—Chelmsford Electric Light Company, Limited. H.T. alternating and continuous current arc lighting. Multi-Lancashire and Paxman boilers, 3 Willans engines, 120 H.P., Crompton dynamos. Overhead and underground mains. 20 arcs, and 250 32-C.P. for street lighting. 2,600 8-C.P. for private lighting. 700 lamps added during past twelve months. Price per unit, 6½d. (sliding scale); gas, 4s. 6d. Engineer, H. B. Price, Arc Works, Chelmsford.

COATBRIDGE.—Scottish House-to-House Electricity Supply. H.T. alternating current. Mordey alternators driven by Dick, Kerr & Co.'s gas engines. No further information.

EASTBOURNE.—Eastbourne Electric Light Company. H.T., alternating system, with house transformers; series system for arc lighting Fowler's engines and boilers; total engine H.P. 400. Lowrie-Parker alternators. Underground main; insulated cables drawn into cast-iron pipes. 26 arc lamps, used for street lighting; 8,400 8-C.P. lamps for private lighting. Price per unit, 9d.; gas, 3s. 2d. Engineer, H. W. Wilkinson, Central Station, Eastbourne.*

EXETER.—Exeter Electric Light Company. H.T. alternating and H.T. series arc. Two compound horizontal, non-condensing engines, 120 H.P. each, and 1 80-H.P. by Fowler, and two Westinghouse triple expansion engines of 25 H.P. 3 Babcock boilers, 150-H.P. each. Underground mains, Fowler-Waring concentric cable. 32 arcs and 6,000 8-C.P. for private lighting. Capacity of station, 6,600 8-C.P., and 60 arc lamps; 1,000 lamps added during the past year. Price per unit. 6d. with rebate; price of gas, 3s. 1d. Cost of station, £11,000. Cost of mains, £7,700. Engineer, H. D. Munro, Rockfield Works, Exeter.

FAREHAM.—Fareham Electric Light Company. Thomson-Houston system. Ransomes, Sims & Co. compound engines. Overhead and underground mains. 20 arcs and 90 incandescent lamps for street lighting, and 320 16-C.P. incandescent lamps for private lighting. Price to consumers 1s. per C.P. per annum and 8d. per unit; gas 3s. 9d. Station, with mains, cost originally £5,000. Negotiations pending for transference of business to the local authorities.*

GALWAY.—Galway Electric Light Company. Low tension system. Crompton and Statter dynamos; 2 Hercules turbines. 7 arcs and 4 incandescents for docks; 1,700 8-C.P. incandescent for private lighting. Price per unit, 5d.; for power, 3d.; gas, 5s. 9d. Engineer, J. E. Pearce.

GLASGOW.—Corporation. L.T. three-wire system, with accumulators for private lighting. 3,000 v. arc machines for street lighting. Latimer Clark-Muirhead dynamos and Willans engines, 1,900 I.H.P. 6 boilers of 300 H.P. each, by Lindsay, Burnett & Co. Brush machines and Easton-Anderson engines for street lighting. Arc light mains are of rubber insulation drawn into iron pipes. L.T. network copper strip in C.I. culverts. About 102 arc lamps have been erected in the streets. 30,000 8-C.P. incandescent lamps for private lighting. Capacity of station, 30,500 8-C.P. lamps. Price per unit, 6d.; gas, 2s. 6d. Cost of system including the taking over of Mavor and Coulson stations up to May, 1893, £60,000. Engineer-in-Chief, W. Arnot.

GLASGOW.—Kelvinside Electric Light Co. L.T. three-wire system, with accumulators. 2 Babcock boilers, 150 H.P., 2 Willans engines, 150 H.P., and Goolden dynamos direct coupled. Underground mains, Callender's covered and armoured type. 4,000 8-C.P. connected for private lighting. Capacity of station, 5,000 8-C.P. burning at one time. Price per unit, 8d.; gas, 2s. 6d. Engineer-in-chief, W. Elsdon Dew.

HANLEY.—Corporation. H.T. alternating current with transformers at sub-stations. 3 boilers, 2 com. vertical engines, 200 H.P. each, 2 of 100 H.P. each, 2 engines and dynamos (continuous current) for street lighting. 30 arc lamps for street lighting. 7,200 8-C.P. and 25 alternating arcs used for private lighting. Underground mains, primary concentric in cast-iron pipes. Low pressure in cast-iron trough filled up with bitumen. The capacity of the station is 10,000 lamps of 8 C.P. Price per unit, 6d.; gas costs 2s. 6d. Extensions projected. Engineer in charge, G. H. Cottam. Corporation Electrical Engineer.

HASTINGS.—Hastings and St. Leonards Electric Light Company, Limited. H.T. alternating current with transformers. Brush engines and Mordey alternators. Underground mains. 4,000 8-C.P. in use. Price per unit, 9d., gas 3s. 9d.*

HOVE.—Hove Electric Lighting Company, Limited. Low pressure 3-wire system. 3 Willans engines, 100-H.P. each. 1 Belliss 150-H.P., and 2 Davey-Paxman, 25-H.P. each. Crompton dynamos. Bare copper mains in culverts. Private lighting equivalent to 15,808 8-C.P. lamps, 9,400 connected since 31st Dec., 1893. 8d. per unit; gas, 2s. 9d. Expenditure to date approximately £39,000. Resident Engineer, C. B. Smith, Cromwell Road, Hove.

HUDDERSFIELD.—Corporation. H.T. alternating current with transformers, Mordey-Victoria alternators, 4 Brush engines of 1,000-H.P., and 4 200-H.P. Babcock boilers. High tension mains are concentric, insulated with vul. I.R.; low tension mains are bitumen covered. Only 4 arc lamps at present for street lighting, 15,000 8-C.P. incandescent for private lighting. Capacity of station, 16,000 8-C.P. lamps. Price per unit, 6d., with sliding discounts to 4½d.; gas, 2s. 9d. Coke is used costing 6s. per ton. Cost of station, when completed, £45,000; mains and transformers, £20,000. Borough Electrical Engineer, A. B. Mountain.

KESWICK.—Keswick Electric Lighting Company. H.T. alternating transformer system. Victor turbines, 50 H.P., and the Westinghouse engine, 50 H.P. Kapp alternator. Overhead wires on Johnson & Phillips fluid insulator. 1 arc lamp and 1,048 incandescent lamps for private supply. Capacity of station, 2,000 8-C.P. lamps. Price to consumers is by contracts based on gas bills; gas, 3s. 3d. per C.P. per annum. Engineer, J. R. Dixon, Stanley Terrrce, Blencathra Road, St. Keswick.*

KILLARNEY (IRELAND).—Lighting done by company. H.T. alternating current with sub-stations (2,000 v.) Underground vulcanised rubber cables. Turbine, 70 H.P. About 500 8-C.P. incandescent lamps for private lighting. Capacity of station, 2,000 8-C.P. Price per unit, 6d.; gas, 5s. Engineer, Victor M'Cowen, Killarney.

KINGSTON-UPON-THAMES.—Corporation. High tension alternating (2,000 v.), with transformer sub-stations. Belliss engines and boilers, Siemens dynamos. Underground mains, Siemens concentric armoured cable. 36 arc lamps, used for streets; 12 arcs and 3,500 incandescents, for private supply. Capacity of station, 5,000 8-C.P., when extensions are complete equal to 9,000. Price per unit, 6d.; gas, 2s. 11d. Cost of station about £20,000; mains, £4,500. Engineer, J. E. Edgcome, Electric Light Station, Kingston-upon-Thames.

KINGSTON-UPON-HULL.—Corporation. L.T. three-wire system, with accumulators. Willans engines, 2 80-H-P. and 2 200-H.P., combined with Siemens dynamos. 3 "Economic" boilers, 200 H.P. each. Underground mains. Crompton bare copper strip and on Callender-Webber system. 11,713 8-C.P. incandescent and 40 arcs, used for private lighting. Capacity of station, 9,000 8-C.P. Price per unit, 6½d. for lighting, 5½d. for places of worship, 5d. for motive power; gas, from 2s. to 3s. Cost of station and mains, £33,600. Borough Electrical Engineer, A. H. Gibbings, Dagger Lane, Hull.

LANCASTER.—Corporation. L.T., 3-wire system, with accumulators. 2 Lanc. boilers, 3 Willans compound engines, aggregate 500 H.P. Underground mains on Callender-Webber system. 14 arc lamps are being placed in the street. 48 arcs and 2,000 16-C.P. used in private lighting. Capacity of station, 4,000 16-C.P. Price per unit, 7d., 4½d. motive power; gas, 2s. 6d. Cost of station up to the present, £16,800, mains, £5,100. Engineer, A. S. Barnard, Town Hall, Lancaster.

MAYFAIR.—Westminster Electric
Street Station. Same system as at E
Paxman and Fraser boilers. Crompt
Same system of mains as other station
W. Kennedy.

WESTMINSTER.—Westminster E
Millbank Street station. Same systen
this company. Willans engines, Ba
nections for the three stations of this c
lamps, about 32,000 lamps have been s
three stations 5,200. Engineer-in-Chie

CHELSEA.—Chelsea Electricity
System, generation of current at 200 vol
of 100 v. each. Batteries in parallel with
Siemens dynamos, Willans engines, ar
mains on Callender-Webber system.
lamps for private lighting, 8,000 lamp
Capacity of station, 50,000 8-C.P. lamps
gas 3s. 1d. Revenue per 8 C.P. l
Frank King, 4, Great Winchester Stree
Still, Draycott Place, Chelsea.

CITY OF LONDON.—City of Lond
and District of St. Saviours. H.T. alte
sub-stations, and L.T. three-wire dis
stations, nearly completed, in which a
aggregating 9,225 H.P. Mordey-Victori
and arc machines. Underground cable
505 arcs for streets, and about 130,000 8-
private lighting. 74,000 8-C.P. added d
station, 150,000 8-C.P. lamps. Twent
been constructed. Price per unit, 8d.,
ing, and cooking. Engineer-in-Chief,

CRYSTAL PALACE.—Crystal Pal
Company. High tension system with
Hornsby engines and boilers (5 of es
in sub-stations. Electrical plant by t
pany, Limited. 6,500 incandescent
lighting. Capacity of stations, 28,000
8d; gas, 2s. 8d. Total outlay, £70,000.

EALING.—Local Board. High
for private lighting, high pressure
Siemens dynamos and Browett & Lin
Fryer refuse destructors are used in
plant. Horse-power of station abou
means of transformer sub-stations.
Capacity of station, 5,000 8-C.P. lamps.

HAMPSTEAD.—The Vestry. Hig
transformer sub-stations, distribution o
arc lighting on continuous current s
boilers, Willans engines of 450 B.H.P
tinuous current machines. High p
cased, armoured, low pressure netw
mains. 22 arcs for street lighting, 2,000
Capacity of station, 11,970. 6d. per uni
Cost of constructing and equipping
Resident engineer, R. A. Chattock,
Road, Finchley Road, N.W.

NOTTING HILL and part of ST.
Hill Electric Lighting Company. L.T.
and Wilcox boilers, Willans engines,
and Crompton dynamos. Undergrou
15,000 incandescent lamps used for priv
15,000 8-C.P. Price per unit, 8d., subje
lamp is about 7s. Cost of station,
Engineer-in Chief, George Schulz, Bulr

KENSINGTON.—Kensington and K
Company, Limited. L.T. 3-wire syst
Babcock boilers, 2,180 H.P., Willan
and Crompton dynamos. Undergroun
and Henley's cable in iron pipes. 63,0
lighting. 16,961 8-C.P. incandescent a
Capacity of station, 43,580, 30-watt l
batteries). Price per unit, 8d. Engi
"Thriplands," Kensington Court, W.*

LONDON Electric Supply Corp
(10,000 v.) with transformer sub-static
and Ferranti alternators. Undergro
65,000 16-C.P. lamps connected. Engin

ST. JAMES'S PARISH.—St. James's
ing Company, Limited. L.T. three-wi
Davey-Paxman boilers, Willans engine
Latimer Clark, Muirhead. Undergrou
armoured cables. 48 arcs and 55,732
10,940 8-C.P. added during the past y
8-C.P. lamps. Price per unit, 6d., with
in-Chief, S. T. Dobson, Carnab Street

ST. MARTIN'S-IN-THE-FIELDS.
Electricity Supply Corporation, Limite
Babcock boilers, Willans engines, a
Underground mains on Callender syst
8-C.P. incandescents used for private lig
the past 12 months. Price per unit is 6
Chief, W. H. Patchell, 12, Maiden Lane,

ST. MARY ABBOTS, KENSINGTON
Supply Company, Limited. Alternati
transformers. 4 compound horizontal Fe
and 1 of 100 H.P.; 3 Babcock and 1 Lanc
28,429 8-C.P. incandescent lamps con
added during the past 12 months. The
is 15,715 8-C.P. 8d. per unit. Total cos
1893, £77,177. Engineer, H. W. Bowden, I

ST. PANCRAS PARISH.—Vestry.
system and accumulators. Babcock boil
and Kapp multipolar dynamos. Underg
in culvert, 98 arcs, two 50 C.P. incandes
and 14,340 incandescent lamps of 16 C.P.,
poses. Present capacity of station, 2
unit, 6d., 3d. for "day" supply; gas 2s
Street station is being increased by thre
dynamos. A new battery sub-station is
Road, and the erection of a new centr
Resident Engineer, J. T. Baron, 47, Stan

STRAND DISTRICT. ST. MARTIN
BONE, PADDINGTON.—Metropolitan
Limited. H.T. alternating transformer
tinuous system. There are five stations,
chester Square, Sardinia Street, Rathbo
dington, and at Whitehall Avenue.
engines by Westinghouse, Willans, H
greaves; dynamos by Electric Construc
mens, and Latimer Clark, Muirhead & Co.
160,000 8-C.P. Price per unit, 7¼d., with
in-Chief, Frank Bailey, 17, South Street,

* No return since last year.

stminster Electric Supply Corporation, Davies
ame system as at Eccleston Place. Willans engines
ser boilers. Crompton and Elwell-Parker dynamos.
ains as other stations. Engineer-in-Chief, Prof. A. B.

.—Westminster Electric Supply Corporation,
tation. Same system as other stations belonging to
Willans engines, Babcock boilers. Total lamp con-
hree stations of this company amount to 163,000 32-watt
0 lamps have been added this year. Total I.H.P. of
0. Engineer-in-Chief, Prof. A. B. W. Kennedy.

lsea Electricity Supply Company, Limited.
n of current at 200 volts and distribution in two parallels
teries in parallel with 200-volt dynamos. Crompton and
, Willans engines, and Babcock boilers. Underground
er-Webber system. 50 arcs and 46,000 incandescent
lighting, 8,000 lamps added during the past year.
n, 50,000 8-C.P. lamps. Price per unit, 8d. with rebates;
enue per 8 C.P. lamp, 8s. 6d. Engineer-in-Chief,
eat Winchester Street, E.C. Resident engineer, Percy
ce, Chelsea.

ON.—City of London Electric Light Company
. Saviours. H.T. alternating system with transformer
L.T. three-wire distributing network. Two central
mpleted, in which are 24 vertical compound engines,
H.P. Mordey-Victoria, Thomson-Houston alternating
. Underground cables on Callender and other systems.
, and about 130,000 8-C.P. lamps and 155 arc lamps, for
74,000 8-C.P. added during the past year. Capacity of
C.P. lamps. Twenty-two transformer stations have
Price per unit, 8d., and 4d. per unit for power, heat-
Engineer-in-Chief,

CE.—Crystal Palace District Electric Supply
tension system with motor generators in sub-stations.
and boilers (5 of each), 7 batteries of accumulators
Electrical plant by the Electrical Construction Com-
6,500 incandescent and 15 arcs used for private
y of stations, 28,000 8-C.P. lamps. Price per unit,
Total outlay, £70,000. Resident engineer, P. J. Rea.

Board. High pressure alternating current
ng, high pressure continuous for public lighting.
and Browett & Lindley engines, Lancashire boilers.
tructors are used in conjunction with steam raising
ver of station about 500. Distribution is done by
rmer sub-stations. 70 arc lamps in the streets.
, 5,000 8-C.P. lamps.

The Vestry. High pressure alternating, with
ations, distribution on three-wire low pressure. Public
ontinuous current series system. 4 200-H.P. Lanc.
ngines of 450 B.H.P. Siemens alternators and con-
machines. High pressure concentric feeders, lead
low pressure network, Siemens triple concentric
street lighting, 2,000 8-C.P. lamps for private lighting.
, 11,970. 6d. per unit with sliding scale; gas, 2s. 10d.
ing and equipping central station, £27,144 approx.
r, R. A. Chattock, Electricity Department, Lithos
oad, N.W.

and part of ST. MARY ABBOTTS.—Notting
ting Company. L.T. direct current system. Babcock
rs, Willans engines, two of 200 and two of 100 H.P.,
namos. Underground mains on three-wire system.
t lamps used for private lighting. Capacity of station,
e per unit, 8d., subject to discount. The revenue per
Cost of station, £24,500. Cost of mains, £35,000.
George Schulz, Bulmer Place, Notting Hill Gate.

Kensington and Knightsbridge Electric Light
l. L.T. 3-wire system, with secondary batteries.
2,180 H.P., Willans engines, 2,120 H.P. Siemens
amos. Underground mains, copper strip in culvert,
e in iron pipes. 63,000 8-C.P. connected for private
C.P. incandescent added during the past 12 months.
n, 43,530, 30-watt lamps on at one time (without
per unit, 8d. Engineer-in-Chief, R. E. Crompton,
sington Court, W.*

c Supply Corporation. H.T. alternating
ansformer sub-stations. Hick, Hargreaves engines
rnators. Underground concentric mains. About
s connected. Engineer-in-Chief, P. Walter d'Alton.*

ISH.—St. James's and Pall Mall Electric Light-
ited. L.T. three-wire. Two stations, in which are
lers, Willans engines, and dynamos by Siemens and
irhead. Underground mains, bare copper strip, and
48 arcs and 55,732 8-C.P. lamps for private supply.
l during the past year. Capacity of station, 63,940
e per unit, 6d., with rebate; gas, 3s. 1d. Engineer-
son, Carnab- Street Station, Golden Square, W.*

-THE-FIELDS.—Charing Cross and Strand
Corporation, Limited. L.T. direct current system.
Willans engines, and Mather and Platt dynamos.
s on Callender system. 15 arc lamps, and 32,000
s used for private lighting. 3,000 lamps added during
Price per unit is 6d. reducible to 5d. Engineer-in-
ell, 12, Maiden Lane, W.C.*

'S, KENSINGTON.—House-to-House Electric
Limited. Alternating current system with house
mpound horizontal Fowler engines each of 200 I.H.P.,
Babcock and 1 Lanc. boilers. Lowrie-Hall dynamos.
descent lamps connected, 4,729 lamps have been
ast 12 months. The present capacity of the station
per unit. Total cost of works, mains, &c., to end of
eer, H. W. Bowden, Richmond Road, Brompton, S.W.

RISH.—Vestry. L.T. continuous three-wire
ators. Babcock boilers, Willans engines, 1,660-I.H.P.
r dynamos. Underground mains, bare copper strip,
wo 50 C.P. incandescent for street lighting; 119 arcs
ent lamps of 16 C.P., and motors used for private pur-
acity of station, 28,000 32-watt-lamps. Price per
lay" supply; gas 2s. 11d. The plant at Stanhope
ng increased by three boilers, and three engines and
attery sub-station is being erected in Regent's Park
tion of a new central station has been commenced.
J. T. Baron, 47, Stanhope Street, N.W.

T. ST. MARTIN S, HOLBORN, MARYLE-
ON.—Metropolitan Electricity Supply Company,
rnating transformer system and low pressure con-
ere are five stations, at the following places: Man-
linia Street, Rathbone Place, Amberley Road, Pad-
hitehall Avenue. Babcock and Wilcox boilers;
ghouse, Willans, Hornsby, Allen, and Hick Har-
y Electric Construction, Westinghouse, Kapp, Sie-
lark, Muirhead & Co. Private lighting is equivalent to
per unit, 7½d., with sliding scale to 5½d. Engineer-
ey, 17, South Street, Manchester Square, W.*

Price per unit, [illegible]; gas [illegible]

R. C. Jackson, Pandon Dene, Newcastle-on-Tyne.

NORTHAMPTON.—Northampton Electric Light and Power Company, Limited. L.T. direct current. 3 Daniel Adamson Lancashire boilers, 3 Scott & Hodgson's vertical compound engines, each of 120 I.H.P., and Crompton dynamos. Crompton system of underground mains. 30 arcs and 5,100 incandescent used for private lighting. Capacity of station, 7,600. Price per unit, 8d., less 5 per cent.; gas 2s. 6d. per 1,000. Revenue per 8-C.P. lamp, 6s. 7d. Cost of constructing and equipping central station, £20,000. Engineer, W. G. Heeman, Electric Light Station, Northampton.

NORWICH.—Norwich Electricity Company. L.T. continuous current three-wire system. 3 Willans engines, 100 H.P. each. 2 Babcock-Wilcox boilers, 140 H.P. each. Underground mains, bare copper, about 2,000 yards laid in culverts, the rest in earthenware pipes on Scott system. Maximum output of station, 1,100 ampères. Capacity of station in lamps, 3,000 16-C.P. Price per unit, 8d. for a period of day between an hour after sunset and 8 p.m., rest of day 4d. per unit.* Engineer, F. M. Long, Duke Street, Norwich

NOTTINGHAM. — Corporation. L.T. 3-wire system. 3 Willans engines of 80 I.H.P., and 3 of 134 I.H.P. Lancashire boilers. Underground mains on Callender-Webber system. 27 arcs and 4,000 8-C.P. used for private lighting. Capacity of station, 10,000 8-C.P. lamps. 6d. per unit, price of gas, 2s. 4d. Cost of station, £45,000, feeders and distributors, £8,411. Engineer, H. Talbot, 19, Addison Villas, Nottinghan.

OGMORE VALLEY.—A company. Low pressure system. Information not up to date.

OLDHAM.—Corporation. Low pressure 2-wire. 2 Lancashire boilers of 350 H.P. each. Willans engines, 2 of 100 H.P. each, and 2 of 60 H.P. each. Bare copper strip in culverts where possible, elsewhere Siemens cables in cast-iron pipes. 14 arcs for street lighting, 4,832 8-C.P. lamps for private lighting. Capacity of station, 6,000. 6d. per unit; gas, 2s. 4d. Cost of constructing and equipping central station, £18,895, which includes land. Consulting Engineer, Professor A. B. W. Kennedy.

OXFORD.—Oxford Electric Light Company.—H.T. continuous current with motor-generator transformers. Three triple expansion engines, surface condensing, marine type of 200 H.P. each, 3 loco. boilers (Mc Laren) of 400 H.P. each; dynamos by Electric Construction Corporation. Underground mains, H.T., Silvertown, L.T., Callender's lead covered. Sixteen arcs used for street lighting, 6 arcs and 10,562 8-C.P. lamps for private lighting, 3,891 8-C.P. added during the past year. Capacity of station, 15,000 8-C.P. Price per unit, 8d., with 5 per cent. discount on accounts paid within the month; gas 3s. 2d. per 1,000. Annual revenue per 8-C.P. lamp, 10s. Engineer, J. Hardie McLean, 45, Broad Street, Oxford.

PORTSMOUTH.—Corporation. H.T. alternating (2,000 volts). Lancashire boilers. 2 300-H.P. horizontal compound engines, by Yates & Thom, are combined with 2 Ferranti alternators; a Parson turbine drives an alternator. Rectifiers are used for the street lamps. Underground mains on Johnstone's patent subway system; other mains by Glovers.*

PRESCOT.—British Insulated Wire Company. H.T. alternating current system. 2 Lanc. boilers. 2 Mordey and 2 Ferranti alternators; 2 Raworth and 2 Browett & Lindley engines. Underground mains on B.I.W. system. 15 2,000-C.P. arcs and 96 16-C.P. incandescent for street lighting, about 1,300 8-C.P. for private lighting. Capacity of station, 2,600. Price per unit, 6d., with discount to 4d.; gas, 4s. 6d. Annual revenue per 8-C.P. lamp, 11s. Engineer-in-chief, G. H. Nisbett.

PRESTON.—National Electric Light Company. L.T. 3-wire system. Belliss direct coupled engines, 2 of 55 H.P., and 8 of 100 H.P., 5 Lancashire multitubular boilers of 250 H.P. each, by Penman & Co., dynamos by Latimer Clark, Muirhead & Co. Underground mains. 12 arcs and 26 32-C.P. incandescent lamps for street lighting, and 58 arcs and 12,000 8-C.P. lamps for private lighting. Present capacity of station 24,000 8-C.P. connected at once. Price per unit, 7d., less 15 per cent.; gas, 3s. 7½d., less 15 per cent. Engineer, J. H. Tonge, 20, Bairstow Street, Preston.

READING.—Reading Electric Supply Company, Limited. Thomson-Houston system. Overhead wires. 2 50-H.P. engines, and 3 25-H.P. engines. 80 arc lamps, and 1,600 8-C.P. incandescent lamps used for private lighting. Price per unit, 8d., arc lamps by contract; gas 3s. to 3s. 3d. Station fully loaded. Engineer, F. F. Yeatman, Electric Light Depôt, Reading. The new central station of this company is in course of construction.

RICHMOND.— (Surrey.) Richmond Electric Light and Power Company, Limited. Low pressure 3-wire system with accumulators. 3 200-H.P. Lanc. boilers by Penman & Co., 5 high-speed engines aggregating 400 H.P. Latimer Clark, Muirhead dynamos. Bare copper strip mains in iron culverts and armoured cables. No street lighting, 13 arc lamps and 4,000 8-C.P. lamps used for private lighting. Price per unit, 7d.; gas, 3s. 1d. Engineer-in-Chief, Percy W. Northey.

SCARBOROUGH.—Scarborough Electric Light Company, Limited. H.T. alternating (2,000 v.) system, with street box transformers in part of the town. 2 Lanc. boilers, 2 150-kilowatt Parsons steam turbine alternators and exciters. 21 arcs and 9,860 8-C.P. incandescent lamps for houses. Underground mains consisting of India-rubber non-concentric cables drawn into cast-iron pipes. Capacity of station, 8,600 8-C.P. lamps. Price per unit, 6¾d. to 5¾d. according to consumption; gas 3s., with discount of 3d. Cost of constructing and equipping station, £24,999; cost of mains, £8,084. Managing director and engineer-in-chief, A. A. C. Swinton, 66, Victoria Street, Westminster. Resident Engineer, G. S. Peck, 102, Westborough, Scarborough.

SHEFFIELD.—Sheffield Electric Light and Power Company, Limited. H.T. alternating system with transformer sub-stations. 5 engines, 650 H.P., 5 boilers, 1,500 H.P. 140 arc lamps and 7,000 8-C.P. lamps. Present capacity of station, 9,500 8-C.P. and 150 arc lamps. Price per unit, 6d., price of gas, 2s. and 2s. 3d. Engineer, Wm. Johnson.

SOUTHAMPTON.—Southampton Electric Light Company. L.T. three-wire system, with accumulators. 2 Willans 100 H.P. engines, and one 60-H.P. direct driving, and one 140-I.H.P. Robey compound, driving Crompton dynamos. Underground mains on Crompton system. 48 arcs of various powers and 4,000 8-C.P. incandescent; current is also supplied to two electric cranes at the Harbour. Capacity of station about 5,400 lamps, with all the plant in use, but engine is reserved for supplying power to the cranes. Price per unit, 8d., with sliding scale; gas, 2s. 13d. The efficiency of engines and dynamo direct driven is 80 per cent. Cost of station and mains, £15,000. Engineer, J. H. Lee, Electric Light Station, back of the Walls, Southampton.

SOUTHPORT.—Corporation. H.T. alternating (2,000 v.) system, with sub-stations. 2 Lancashire boilers, 3 Browett & Lindley engines and Mather and Platt alternators, rope driven, of 160 kilowatts capacity. Underground mains, concentric armoured cables. The boilers are constructed for burning coke breeze from the Corporation Gas Works. 20 arcs and 4,000 8-C.P. for private lighting. Cost per unit, 7d.; as, 3s. Works have cost about £13,000, mains cost about £5,500. Engineer Arthur Ellis, Town Hall.

WOOLWICH.—[illegible]

H.T. alternating transformer system. Chandler high-speed engines, 250-H.P. Underground mains in cast-iron pipes. 2,500 35-watt incandescent lamps and 14 arcs used for private lighting. Capacity of station, 5,000 lamps. Price per unit, 6d., gas 2s. 5d. Cost of station £9,000 approx. Engineer, G. E. B. Pritchett, 31, Soho Square, W.

WORCESTER.—Corporation. High pressure alternating with transformer sub-stations. 3 Brush compound vertical engines, each of 286-H.P. 2 54-in. turbines, each of 161-B.H.P. 1 48-in. of 123-B.H.P. 1 30-in. of 47-H.P. 4 Babcock and Wilcox water-tube boilers, each 125-I.H.P. Brook's oil mains. Concentric paper insulation mains for high pressure, and Callender's concentric for low pressure. 27 arc lamps for street lighting; 4 arc lamps and 4,000 incandescent for private lighting. Capacity of station, 11,000 8-C.P. lamps. 5d. per unit for lighting, 3d. for power; gas, 3s. 7d., less discount. Cost of constructing and equipping central station, including mains, £42,000. Borough Engineer, Thomas Caink.

GREAT YARMOUTH.—Corporation. High pressure alternating current. Babcock boilers, 400-H.P., and Willans engines, armoured cables. 60 arcs for lighting streets and Fish Wharf. Works not sufficiently advanced to take on private lighting. Capacity of station in 8-C.P., 4,500. 6d. per unit; gas, 3s. 2d. and 4s. 6d. Cost of constructing and equipping central station, £16,500. Consulting Engineer, W. H. Preece.

STATIONS NOT YET RUNNING.

ACCRINGTON.—Corporation have received sanction for borrowing powers to the extent of £10,000, and have purchased a site for the central station.

BELFAST.— The Corporation electric light station in course of erection. Gas engines are to be employed. Consulting Engineer, Prof. Kennedy.

BLACKBURN.—Low pressure continuous current. Works in course of construction.

CHELTENHAM.—Corporation. High pressure alternating. Station in course of construction. Price will vary from 6d. to 3½d. per unit according to quantity consumed.

CHESTER.— Low pressure 3-wire system. Local Government Board Enquiry has been held.

COVENTRY.—Corporation. High-pressure alternating with low pressure distributing mains. 2 Lancashire boilers, 2 horizontal compound engines of 200 I.H.P. and 100 I.H.P. respectively; Hall alternators; concentric mains. 6d. per unit; gas, 2s. 7d. Station estimated to cost £20,000. R. Hammond, Consulting Engineer. Station will be completed early next year.

EDINBURGH.—Corporation. A low pressure continuous and a high pressure alternating. Works will be completed early next year. Prof. Kennedy, Consulting Engineer.

FLEETWOOD.—Corporation. Works not yet ready. Contracts are let subject to sanction for borrowing powers.

HALIFAX.—Corporation. High tension alternating system. Compound horizontal engines 500. Underground mains vulcanised, in iron pipes. 20 arcs and 5,000 8-C.P. for private lighting. Capacity of station, when completed, will be 10,000 8-C.P. 6d. per unit, 5 per cent. discount for cash. Price of gas, 2s. 2d. Station about completed. Cost of constructing and equipping station, £35,000. Cost of mains, £9,000. Electrical Engineer, T. P. Wilmshurst.

HARROGATE.—Corporation. H.T. alternating current system proposed, but scheme in abeyance.

ISLINGTON.—Vestry. High pressure alternating current works are in course of construction. Engineer, Albert Gay.

LEICESTER.—High pressure alternating current with transformers. Mordey alternators combined with Hick Hargreaves engines.

NEWPORT.—Corporation. High pressure alternating system. Lancashire boilers, 4 sets of 150 H.P. engines, Hall alternators. Concentric mains in culverts for high pressure, armoured cable for low pressure. 40 arc lamps to be used for street lighting; 7,000 incandescent and 40 arcs for private lighting. Capacity of station, 15,000 8-C.P. Price per unit, 6d.; gas, 3s. Cost of constructing and equipping central station, £30,000, including mains. Consulting engineer, R. Hammond, Ormonde House, Great Trinity Lane, E.C.

SOUTH SHIELDS.—Corporation. Works in course of construction.

STAFFORD.—Corporation. A scheme of Dr. John Hopkinson is being proceeded with.

SUNDERLAND.—Corporation. Low-pressure system for central area, and high-pressure for outlying districts. Lancashire boilers, and Willans engines. India-rubber cable in Doulton casing for low-pressure and concentric for high. Capacity of station 6,000 8-C.P. lamps. 6d. per unit with discounts varying from 2½ per cent. to 20 per cent.; gas 2s., with discount. Station is in course of construction; will be ready about the beginning of 1895. Consulting Engineer, Prof. Kennedy; Resident Engineer, C. S. Vesey Brown.

TUNBRIDGE WELLS.—Corporation. High pressure alternating system. Babcock boilers, Willans engines, and Johnson & Phillips dynamos. It is intended to commence with 24 arc lamps in the streets. The works are in course of construction, and Mr. W. H. Preece is superintending the erection of the works. Town Clerk, W. C. Cripps.

WOLVERHAMPTON.—Corporation. H.T., direct (2,000 volts), with motor transformers. 3 Lancashire boilers, 2 250-I.H.P. Marshall horizontal compound condensing, one of 125 by same makers; dynamos by Electric Construction Corporation. Underground mains; armoured cables for distribution, armoured concentrics for arc lamps, and Callender solid for H.T. feeders. 42 arc lamps to be used for street lighting 56 arcs and 5,000 8-C.P. lamps will be used for private lighting. Capacity station, 10,000 8-C.P. Price per unit, 6d.; gas, 2s. 9d. Station will probably cost £22,000, mains £5,700. Borough Electrical Engineer, F. Harman Lewis, Town Hall, Wolverhampton.

Abbreviations:—H.T., high tension; L.T., low tension.